USAID GAPKINDO IRRI CIRAD ICRAF S.E. Asia

SMALLHOLDER RUBBER AGROFORESTRY PROJECT

SRAP

TECHNICAL REPORT ON

Rubber Agroforesty System (RAS)

on-farm experimentation in Indonesia

PART 3
JAMBI
WEST-SUMATRA

AND SUMMARY OF RAS ECONOMIC ANALYSIS

Prepared by Eric Penot

Associated scientist ICRAF / CIRAD-TERA
ICRAF Southeast Asian Regional Research Programme,
Jl. Gunung Batu No. 5, P.O. Box 161 Bogor 16001
INDONESIA

Tel : (62-0251) 315234, Fax (62-251) 315567
E-Mail : Penot@cirad.fr

Main results for Jambi

Main agronomic results of the RAS experimentation in Jambi

PRELIMINARY RESULTS OF RUBBER AGROFORESTRY SYSTEMS (RAS): *ON-FARM EXPERIMENTATION OF RAS 1 IN JAMBI PROVINCE.*

G. Wibawa, E. Penot and S. Williams

I. INTRODUCTION

Rubber is the predominant tree crop in the area of Rantau Pandan and Senamat Districts of Muara Bungo region in the province of Jambi. Most of this rubber is produced by smallholders in areas through jungle rubber systems. The emergence of this complex rubber agroforest was closely related to the slash and burn and shifting cultivation system which has been traditionally practiced by the farmers.

The productivity of rubber on this type of farming system is very low, around 600 kg d.r/ha/year or between a half and one third of that of monoculture smallholder rubber development projects or estate plantations. Various researchers (Barlow and Muharninto, 1982; Gouyon and Nancy, 1987; Hadi, 1995) have identified the causes of this low productivity: 1) old rubber with damaged tapping panel 2) native unselected rubber seedlings where the plant yield variability is very high 3) density of rubber ranging from very high (more than 800) to low (less than 150) trees per ha, due to the high risk of pests (pig, monkey, deer, tapir) and combinations of other trees. 4) longer immature period before tapping

Besides the economic disadvantages, benefits of this complex agroforest can be considered in terms of conservation of a certain level of biodiversity (de Foresta, 1992) and low establish cost in term of labour and capital (cash demand). For the farmers, whose average annual on farm income per household was Rp. 1.3 millions and average total annual expenditure was around Rp 1.2 millions (Gintings *et al.*, 1996), an extensive farming systemis the best strategy to continue to provide land and rubber. Average size of land holding for rubber per household on these areas ranged between 0.5 and 4.0 ha and average size of family is 4.8 persons (Gintings, *et al.*, 1996).

Amypalupy (1994 and 1997) showed that the growth of two year old rubber (GT1 clone) was significantly retarded when Imperata (alang alang) was strip weeded (2 m wide) manually three times/year. However when alang alang was weeded chemically, by spraying glyphosate, with the same frequency, the rubber growth was comparable to that where the land was totally weeded. Application of a double dose of recommended fertilizers on chemically weeded plots did not increase the rubber growth. Wibawa *et al.* (1997) showed the stem diameter of rubber of BPM24 clone in clean weeded plots was twice as great as that where the rubber interrows were invaded by a mixture of weeds (shrubs, Imperata, forest regrowth) . The difference of stem diameter was observed as early as one year after planting and become statisticaly significant at two years after planting. Manual strip weeding at least four times a year, in the rubber plots

II. MATERIALS AND METHODS

The on-farm trials have been carried out in three villages of Muara Bungo region in Jambi province since December 1995. RAS methodology has been presented in Penot, 1995.

In the system called RAS 1.1, rubber was planted with 6m X 3m spacing in two phases: December 1995 to February 1996 with one whorl GT1 clone in polybag, and October to November 1996 with one whorl PB260 clone in polybag . The first phase of planting was located at two villages: Rantau Pandan in (two farmers' fields) and Muara Buat (three farmers' fileds). The second phase of planting was located in Sepunggur village at six farmers' site. In the system called RAS 1.2, in different rubber clones were planted in December 1996 at location in the same villages in five farmers' fields.

RAS 1.1 system

In each farmers' field, a series of treatments were applied and randomuized following a standard block design. Each farmer is considered as one replication. The treatments consisted of three levels of strip weeding, compared to one control standard plot (TCSDP):

Plot A (control) : standard smallholder development project (TCSDP) management using leguminous cover crops (LCC) as an intercrop. Manual weeding is carried out nine times a year at 1m of each side of rubber tree rows.

Plots B, C and D : low, medium and high intensities of strip weeding (2m wide) are applied 3, 6 and 9 times a year respectively.

RAS 1.2 system

The treatment applied consisted of two factors: frequency of strip weeding and rubber planting materials. The first factor has two levels which are 3 and 6 times strip weeding per year and the second factor has five levels: seedling as control, RRIC 100, RRIM 600, BPM 1 and PB 260 clones. As in the RAS 1.1 system, all treatments were applied at each farmers' field except for two farmers where a half of the total treatments, but both with control seedling plot, were implemented: Harahap's plot has two clones (RRIM 600 and BPM 1) and Yusuf's plot has the other two clones (RRIC 100 and PB 260). The size of each plot is around 1000 m^2 or a total of 4000 m^2 and 10000 m^2 in RAS 1.1 and RAS 1.2 respectively.

In all trials, rubber was fertilized with 115 g SP36/ tree equivalent to (200g of Rock phosphate) aplanting time and 50g of Urea /tree every three months, starting three months after planting.

RAS 2 system

Two types of RAS 2 trials have been implemented after preliminary discussions with farmers groups in 3 selected villages : RAS 2.2 (with food intercrops such as rice and palawijas[1]) and RAS 2.5 where rubber is combined with cinnamon.

RAS 2.2 experimentation

Some farmers wishes to grow rice or palawijas continuously for the first 3 years after planting during immature period. Different strategies have been observed with the 7 fields (with 7 farmers). The original methodology has not been adopted by farmers and we take the decision to transform the RAS 2.2 replications into an observation trials where we observe or compare different cropping patterns according to farmers strategies. Plots have been reallocated with the following systems with only 2 replications per system. No ANOVA analysis is therefore possible but the qualitative analysis is fruitful and shows very interesting results. We must admit that RAS 2.2 is very successful for some farmers (here again the importance of a relevant operational typology to adapt the type of RAS to the recommendations domains) with a high level of adaptation according mainly to labour resources. Originally, each field is divided with the following plots :

- with and without associated trees
- rice : with and without fertilization.

Rice has almost failed in all plots in the first year. Palawijas have been very successful except soybean (obviously planted too late) in 1 field (Yani's field.

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[1]Palawijas are secondary crops such as groundnut, pulses, vegetables, cassava, other roots and tubers....basically foodcrops other than rice.

Table 1b. **Plot characteristics in RAS 2 experimentations**

Plot	Rep	Associated trees	Intercrops	Farmers' plot	Field's plot	Treat-ment	Clone
1 2	1 and 2	no	alang²/control	Adnan1	all field	1	GT1
3 4	1 and 2	no	alang²/control	Adnan1	all field	2	PB 260
5	1	no	palawija1/rice/ dose 0	Saer	A	3	GT1
6	2	no	rice/dose 0	Alias	A	3	GT 1
7	1	yes	rice/dose BPS	Alias	B	4	GT1
8	2	yes	rice/dose CIFC	Alias	C	4	GT 1
9	1	yes	palawija1	Saer	B	5	GT 1
10	2	yes	palawija1	Saer	C	5	GT 1
11	1	no	palawija1	Sabri	A	6	GT 1
12	2	yes	Palawija1	Sabri	B	6	GT 1
13	1	no	no palawija	Sabran	A	7	GT 1
14	2	yes	no palawija	Sabran	B	7	GT 1
15	1	no	palawija2	Joni	A	8	GT 1
16	2	no	palawija2	Joni	A	8	GT 1
17	1	yes	palawija2	Joni	A	9	GT 1
18	2	yes	palawija2	Joni	A	9	GT 1

Data collection

Soil analysis was carried out, at two soil depths (0-5 and 5-20cm), on pH, Org. C, N, P, K, Ca, Mg, Na, CEC and Al. Aluminum saturation was then calculated. Rainfall was mesured manually at three locations, representing the studied areas.

Rubber growth is measured three monthly on stem diameter at 10cm above union at the first year and at 100cm above union thereafter, height and number of whorls. The weeds were characterized qualitatively by average height and coverage.

Rainfall and Soil analysis

The average annual rainfall around the area of Muara Buat and Rantau Pandan was 2898 mm (six years data from Rantau Pandan station). The rainfall in Rantau Pandan area was lower than that in Muara Buat. From January to June 1997, rainfall in Rantau Pandan was more or less comparable to that of the average of six years at the same period, but in Muara Buat, rainfall over

III . RESULTS AND DISCUSSION

RAS 1.1 system

The effects of frequencies of weeding: 3, 6, 9 times/year (including the control plot in monoculture) are not yet statistically significant (no differences) , in all farmers' plots, showing clearly that 3 weeding per year are sufficient to enable rubber to grow properly in an agroforestry environment.. Rubber growth on the first phase trials were higly variable among farmers. This variation was mainly due to the factors outside of the weeding treatments (Figure 2). Rubber clones can grow normally on the steep slope like in Ismail's (ISM) field. Rubber growth in this field was not significantly different to that on Azahri (AZR) field where the topography of the latter is less steep than the first (Figure 2).

The stem increment variations within and between farmers' field were higher during the period of May to August (dry season) than during February to May (rainy season) (Figures 2b and 2c). On farmers' lands like those of Bustami (BUS), Saryono1 (SAR1) and Saryono2 (SAR2), the slow rubber growth was due principally to the pest damage (wild pig, red monkey), rather than weeds. The surrounding vegetation seems to be related closely to that damage. In these fields, plots which are located at the border of secondary forest or jungle rubber were damaged more seriously highly than those plots located in the centre of the field.

Muara Buat and Rantau Pandan are representative of pionner or buffer-zone where agroforestry systems are still very extensive with a relatively low presence in the fields. The proximity of secondary, even sometimes, primary forest is a reservoir of potential pests for improved rubber.

(a)

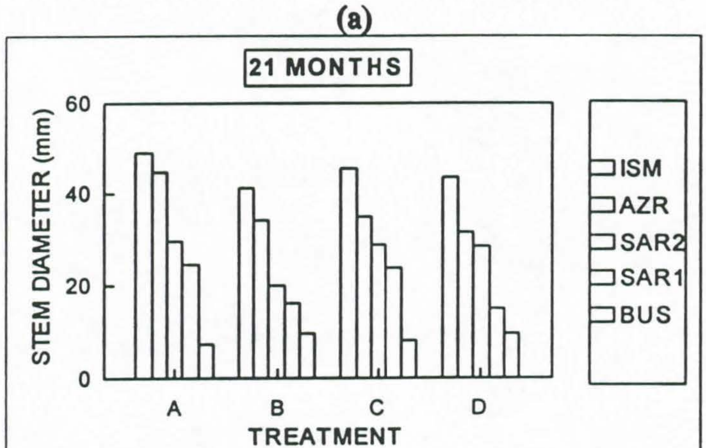
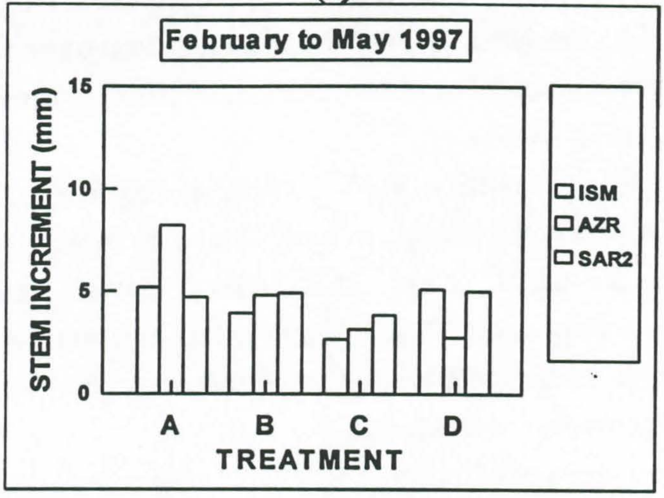


Figure 2. Effect of frequencies of weeding on stem diameter, at different farmers' fields at 21 months (1st phase) (a).

(b)



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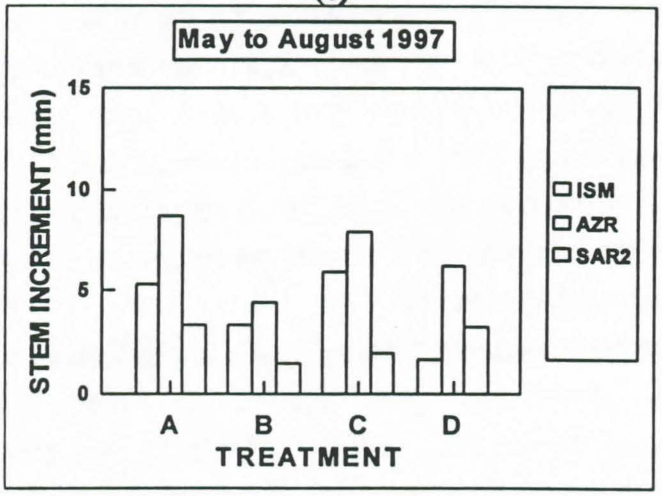


Figure 2 (cont). Effect of frequencies of weeding on stem diameter increment, at different farmers' fields during the period February to May (b) and May to August 1997 (c) .

Different systems of pest control (fencing, including fences around individual rubber trees, poison, scaring the pests with rifle) have been tried by the farmers and also by the SRAP team to decrease the damage, but non of these methods was totally effective. any of the system can protect the attack optimally. The existance of a hunting group at Muara Bungo to help farmers to decrease the pest damage may be a good alternative of pest control. It seem that guarding the field (living in the field, coming freequently) may reduce attack. The time available for that activity is very limited, due to the off-farm works which gives farmer s a real cash income.

In the areas with high risk of pest damage, farmers consider that the risk of pest damage is increased when rubber rows are weeded. However, based on our field observations, this

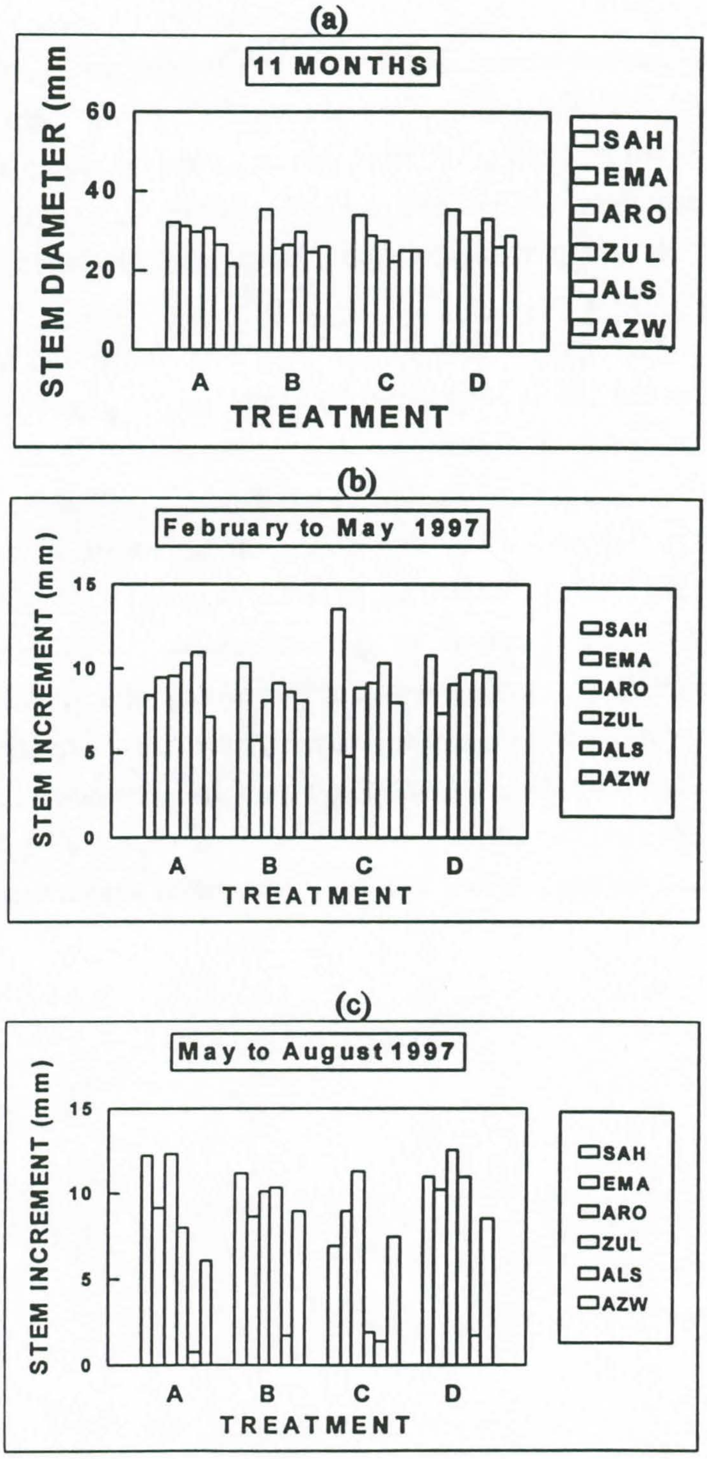
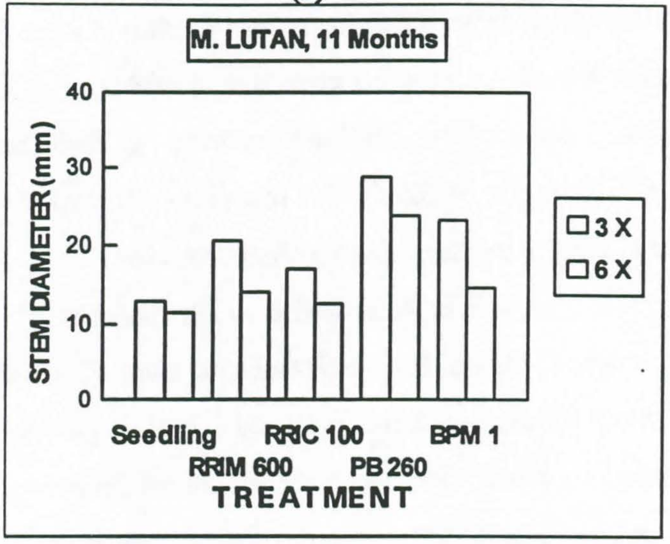


Figure 3. Effects of frequencies of weeding on rubber stem diameter (a), on stem diameter increment at two periods (b and c) at different farmers' fields (2nd phase)

(a)



(b)

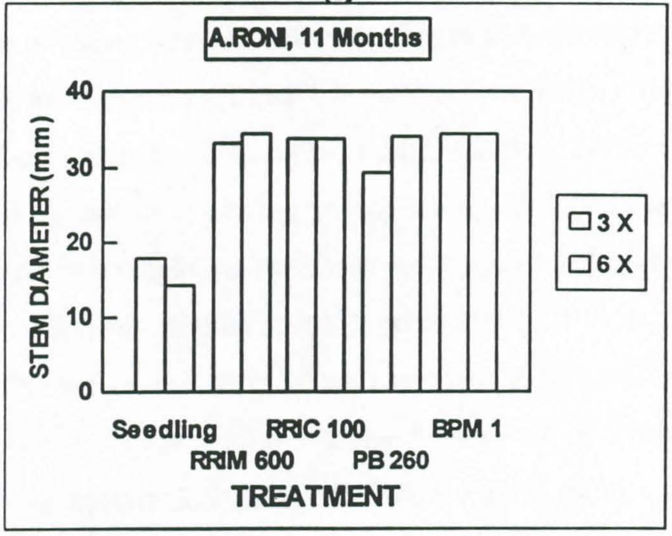


Figure 4. Comparaison of stem diameters of 11 month old rubber (clones and seedling) with two levels of weeding at M.Lutan's field in Rantau Pandan (a) and M. Roni's field in Sepunggur (b).

Table 2. Rubber stem diameter in different farmer's fields and at different dates of measurement

DATA AVERAGE RAS 2.2

			TIME SERIE 1	2	3	4
Farmer	Kode	Plot	Diameter	Diameter	Diameter	Diameter
Adnan_(	1	A	7.36	12.55	14.64	17.2
		B	7.59	12.66	15.14	16.73
Adnan_F	2	A	7.53	9.19	12.37	13.05
		B	5.47	6.67	10.65	10.33
Saer+Ali	3	A	15.63	22.05	34.46	37.15
		A	9.88	18.69	27.32	28.75
Alias	4	B	10.92	25.29	34.92	35.85
		C		25.14	34.97	36.65
Saer	5	B	15.63	24.53	31.59	38.56
		C		24.20	38.04	39.1
Sapri	6	A	10.69	21.17	29.77	31.73
		B	11.29	23.60	34.65	35.52
Sabran	7	A	11.14	21.11	31.24	34.46
		B	11.01	22.11	33.63	32.71
Yani	8	A	18.58	33.40	42.94	42.56
		B	15.41	27.57	36.69	37.37
Yani	9	C	9.94	20.41	26.62	26.13
		D	10.06	19.43	27.65	26.65

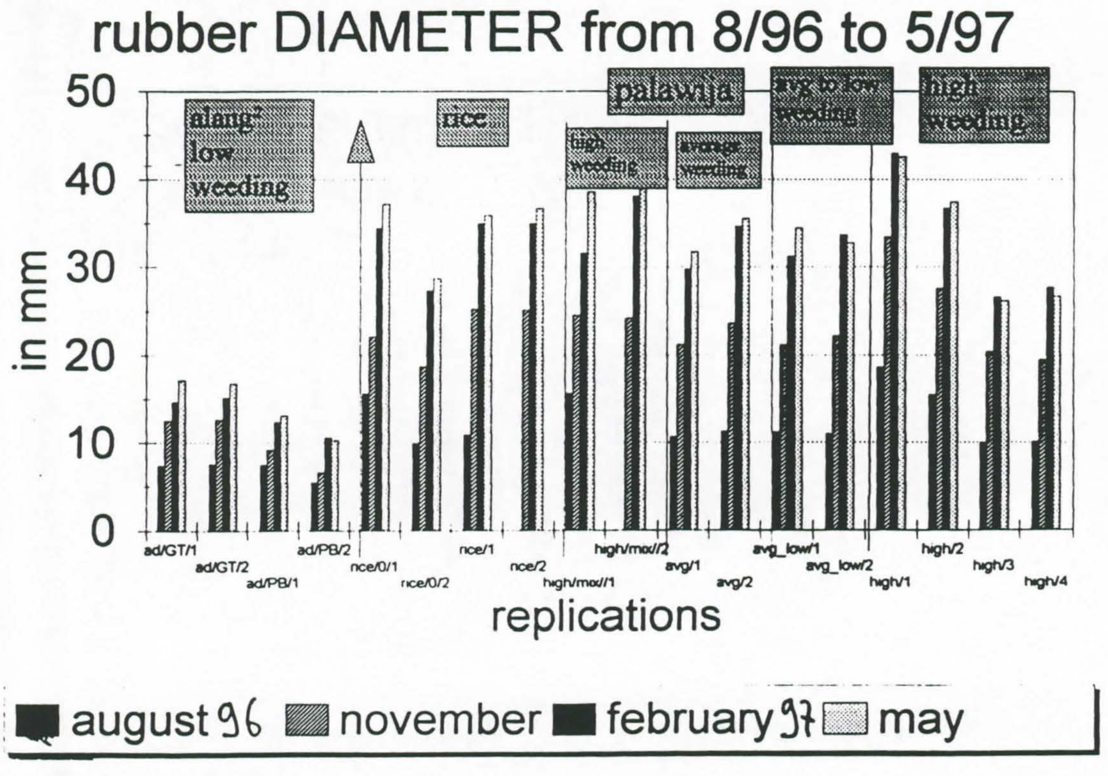


Figure 5. Rubber stem diameter in different farmer's fields and at different dates of measurement

Table 4. Number of whorls of rubber in different farmer's fields and different dates of measurement

DATA AVERAGE RAS 2.2

			1	2	3	4
Farmer	Kode	Plot	Total whorls	Total whorls	Total whorls	Total whorls
Adnan_(	1	A	2	3	5	5
		B	2	3	5	5
Adnan_F	2	A	2	2	4	4
		B	2	2	4	3
Saer+Ali	3	A	3	4	9	9
		A	2	3	6	6
Alias	4	B	3	5	8	8
		C		4	8	8
Saer	5	B	3	5	9	9
		C		5	7	9
Sapri	6	A	3	4	8	9
		B	3	4	9	9
Sabran	7	A	3	4	8	9
		B	3	4	8	9
Yani	8	A	3	5	10	10
		B	3	4	8	9
Yani	9	C	2	3	5	6
		D	2	3	5	6

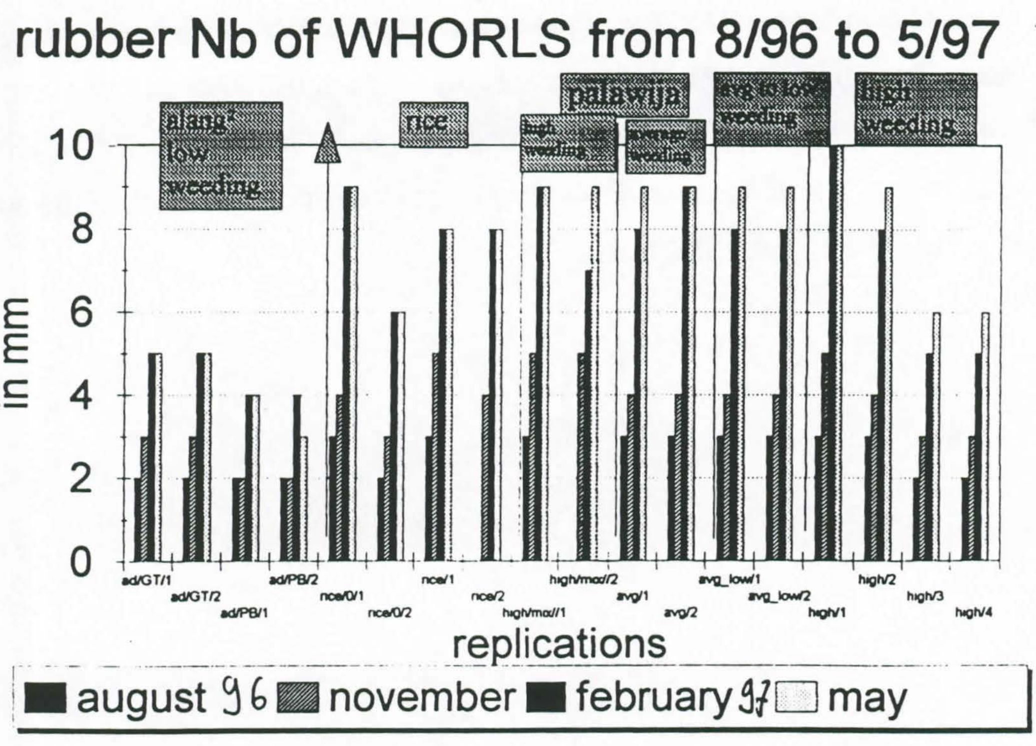


Figure 7. Rubber stem diameter in different farmer's fields and at different dates of measurement

IV. CONCLUSION

Different constraints on rubber growth in different RAS systems, during the first two years of experimentation, were well recorded. The most important constraint was the vertebrate pest damage (monkeys, pigs) which masked the treatment effects, on certain farmers' fields, inparticulary in hilly areas and remote or buffer zones. The variability of the farmers conditions was caused by a number of bio-physical as well as socio-economic factors.

The advantage of the on-farm trials is that these resultst are representative of real world conditions. It was possible to identify factors which affect rubber growth in the farmers situation which may actually have a greater influence than the treatments originally planned in the experiments. For exemple, the extent of the problem of pest damage was not expected, and would not have been detected if experiment were carried out on-station. As a results of the research described above, pest damage has been identified as a major constraint to clonal rubber establishment in pioneer zones, or relatively remote areas, including the piedmont of the Barisan moutains in Sumatra.

In spite of the problems mentioned above, we are still able to conclude that strip weeding of three to four times a year is sufficient to enable good establishment of clonal rubber in the first critical year of weed competition in RAS 1 type systems. It was also observed that the growth of clonal rubber in this conditions is better than that of unselected local seedlings. Therefore these results sugest that during the very critical first two years, clonal rubber can survive and grow well in the RAS 1 (rubber+secondary forest) environment.

It's too early to conclude that one clone is definitely best in this environment, however PB260 seem to show consistently good growth.

Concerning RAS 2.2 (Rubber+associated trees+palawija), intercropping of palawija and an average number of associated fruits and timber trees (100 to 150 trees/ha) does not affect rubber growth as rubber is directly profiting from palawija weeding. It is quite clear that weeding on palawijas and associated trees clearly profit to rubber and enable farmers to optimize their labour input.

RAS 2.5 (rubber+cinamon) seems to be still an interesting system according to the growing market for cinnamon, but our trials are not representative and we should aknowledge that the site selection has not been successfull.

These preliminary results suggested that RAS 1 and 2 technologies are successfull, in certain conditions and in particularly at the conditions that RAS type is well targeted to farmers class depending on farming strategies.

However, vertebrate pests does not allow RAS development in areas where farmers put priority on very extensive systems (low presence in the fields) or is remote areas, close to existing forest

V. REFERENCES

Amypalupy, K. 1994. Pengaruh pengendalian alang alang secara minimal terhadap pertumbuhan tanaman karet rakyat pada periode tanaman belum menghasilkan. Bull. Perkaretan, 12(1):10-14

Amypalupy, K. 1997. Pengkajian pengendalian alang alang secara mekanis dan kimiawi pada periode tanaman belum menghasilkan. Balit Sembawa, KTI-438/a.

Barlow, C dan Muharminto. 1982. Smallholder Rubber in South Sumatra. Toward Economic Improvement. Doc. BPP Bogor dan ANU. 78 pp.

De Foresta, H. 1992. Complex agroforestry system and conservation of biological diversity: for a large use of traditional agroforestry trees as timber in Indonesia, a link between environmental conservation and economic development. Proceeding of an international conference on the conservation of tropical biodiversity. Malayan Nature Journal.

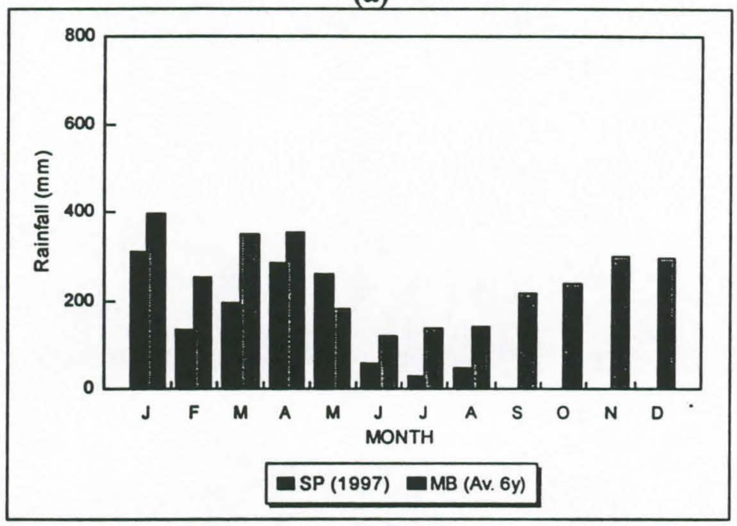
Gintings et al., 1995. Characterization Rantau Pandan, Muara Tebo, Jambi: Basic Information for combating deforestation caused by Slash and Burn Agriculture. Paper presented at Regional workshop on Alternatives to Slash and Burn.

Gouyon, A and C. Nancy. 1989. Increasing the productivity of rubber smallholder in Indonesia: a study of agro-economic constraints and proposals. Paper presented at Rubber Growers Conference. 26pp.

Hadi, P.U. et al., 1995. Socio-Economic characterization of Slash and Burn Agriculture at the community level in three ecological zones of Sumatra, Indonesia. Paper presented at Regional workshop on Alternatives to Slash and Burn.

Wibawa, G and Thomas. 1997. Study of hevea based intercropping system functioning: A. Effect of different intercrops on rubber growth. Paper presented on Seminar on study of hevea based intercropping system functioning. Balit Sembawa. 25pp.

(a)



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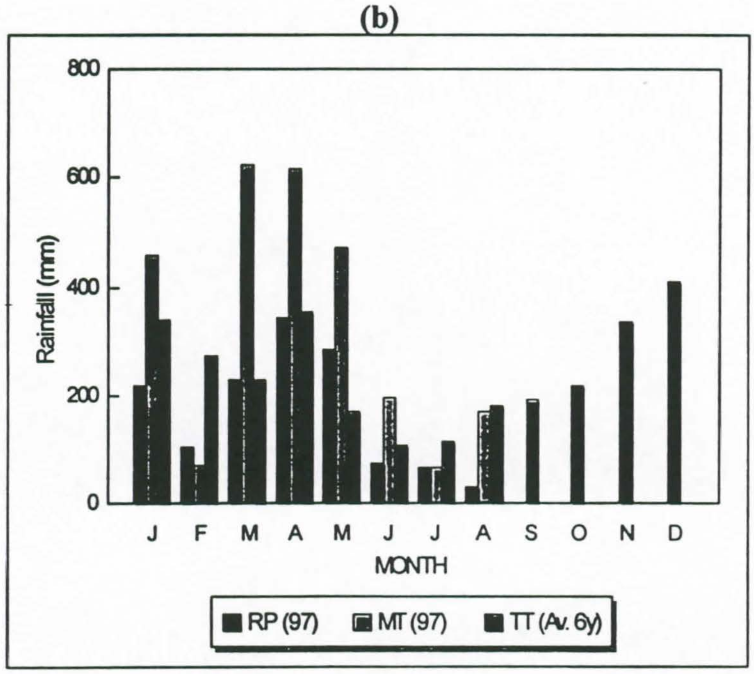


Figure 1. Average rainfall in around and Sepunggur (a), Rantau Pandan and Muara Buat (b) compared to the 6 years data from the closest representative station.

SimplifiedTCSDP based fertilization programme for JAMBI is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
UREA		50	50	50	50
SP36		0	0	0	0
KCL		0	0	0	0

RAS protocols in Jambi

RAS METHODOLOGY

RAS 1.1/WEEDING
TRIAL PROTOCOL

Jambi province

MEMO / RAS METHODOLOGY

RAS 1.1/WEEDING

TITLE
Clonal rubber in agroforestry environment : genotype x environment interaction.

OBJECTIVE/HYPOTHESE
OBJECTIVES
- To investigate the growth of an improved rubber clone (GT 1/trial 1 and PB 260/trial 2) in close to jungle rubber conditions, under various intensities of weeding, with emphasis on the critical first 2 years of establishment.

- To compare growth of this clone under currently prescribed 'standard' (theoretically optimal) plantation management conditions (TCSDP technological package), with its growth under three variants of close to jungle rubber management (differing by increasing intensity of weeding on the rubber row). Secondary forest is allowed to grow in the inter-row.

Hypotheses

Main Hypothesis
- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note : clones have never been tested in close to jungle rubber conditions).

Secondary Hypotheses
- 1. Increased intensity of weeding only within the row will not affect the regenerative capacity of the useful secondary forest species (e.g : fruits and timber trees, rattan....). E.g. constant disturbance will not preclude the establishment of useful secondary forest species due to e.g. dominance of grasses (or ferns)
(Theoretically this disturbance should not be too detrimental to soil fertility, if slash is left as mulch. Soil is still protected)
- 2. Increased intensity of weeding only within the row will not affect the susceptibility to invasion by Imperata, except on the row.
- 3 Secondary forest regrowth in the inter-row may not be more competitive than a leguminous cover crop used in the inter-row in terms of rubber growth.
- 4 Classical LCC used for rubber are viny species and required more weeding than natural forest regrowth.

For the other years : see the following table :

Jambi

PLOT/year	**1**	**2**	**3**	**4**	**5**
A	3x	1x	0	0	0
B	6x	3x	1X	1X	1X
C	9x	6x	3x	3x	3x
D + LCC	9x + LCC	6x + LCC	3x + LCC	3x + LCC	3x + LCC

EXPERIMENTAL DESIGN
EACH TRIAL IS PROCESSED SEPARATELY with respectively 5 (1995) and 6 rep (1996).
Randomized block system : The trial 1 planted in 1995 has severally suffered from attacks of monkeys and pigs and will have only a qualitative analysis.

RUBBER
FERTILIZATION
Simplfied TCSDP fertilization programme with SP 36 at planting time (115 grams per tree) and UREA (50 grams per tree, every 3 months) only for the first 2 years. No fertilization later.

SimplifiedTCSDP based fertilization programme for JAMBI is the following:
IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
UREA		50	50	50	50
SP36		0	0	0	0
KCL		0	0	0	0

PLOT RANDOMIZATION FOR TRIAL 2 : planting in October 1996

1 PAK AZUAR

9X	6X	3X	9X + LCC

2 PAK ALJUPRI

9X	9X + lcc	6X	3X

3 PAK ZULKIFLIN AND 4 PAK SARONI

9X + LCC	9X
9X	3X
3X	6X
6X	9X + LCC

JALAN

5 PAK eman

3X	6X	9X	9X + LCC

RAS METHODOLOGY

RAS 1.2/CLONE COMPARISON TRIAL PROTOCOL

JAMBI

RAS 1.2/CLONE COMPARISON

TITLE
Clonal rubber and unselected seedlings in agroforestry environment : genotype x environment interaction.
2 treatments : Clone comparison (4 clones + seedlings) with 2 levels of weeding.

OBJECTIVE/HYPOTHESE
OBJECTIVES
- To investigate the growth of 4 improved rubber clone (with PB 260 and unselected seedlings as controls) in RAS 1 environment (close to jungle rubber conditions), under 2 intensities of weeding, with emphasis on the critical first 2 years of establishment.

Hypotheses

Main Hypothesis
- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note : clones have never been tested in close to jungle rubber conditions).
- it is necessary to rely on several clones rather than only one to limite risks and increase adaptability of clonal planting material in jungle rubber conditions. It may be expected that jungle rubber conditions increase the risk of leaf diseases compared to that of monoculture due to higher moisture level and microclimatical conditions more favourable to fungus development.

Some clones may be more adapted than other for RAS 1 among those 4 clones which have been selected for all RAS trials. The performances of clones will be compared to that of unselected seedlings and PB 260 which is considered as the clone benchmark.

EXPECTED OUTPUTS

- To produce recommendations on clonal recommendations in RAS 1.

LOCATION : Jambi, Kamubaten Muara tebo.
Also in West-Kalimantan province, Kabupaten Sanggau, Kecamatan Sanggau kapuas, villages of Embaong.
Total 6 replications for october 1996 planting.

EXPERIMENTAL DESIGN
Strip split plot with main treatment on clones, secondary treatment on weeding level.
Control is PB 260 plot.

RUBBER
CLONES
Fast growing clones : PB 260 and RRIC 100
Medium growth clones : BPM 1 and RRIM 600

FERTILIZATION
TCSDP fertilization programme :
- 200 grams of RP or 115 grams of SP 36 per trees at planting time.
- 50 grams of urea (N) per tree every 3 months only for the first year only. No fertilization later.

SimplifiedTCSDP based fertilization programme for JAMBI is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
UREA		50	50	50	50
SP36		0	0	0	0
KCL		0	0	0	0

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

INTERCROPPING
Nothing or local rice the first year (with some palawijas such as corn and cassava). No fertilization of intercrops the year 1.
In Jambi : no intercrops.

PLOT RANDOMIZATION FOR JAMBI

1 pak MAOWI

TRENCH EXP	BPM 1	RRIM 600	Seedlings	PB 260	RRIC 100	3X
PB 260	BPM 1	HOLE NOT USED	RRIM 600	RRIC 100	Seedlings	6X

2 PAK HADJI DUR

SEEDLINGS	RRIC 100	BPM 1	RRIM 600	PB 260	3X
BPM 1	PB 260	RRIM 600	RRIC 100	SEEDLINGS	6X

JALAN

3.1 PAK HARARAP : half rep

seedlings	RRIM 600	BPM 1	3X
SEEDLINGS	BPM 1	RRIM 600	6X

RIVER

RAS 1.3/RUBBER FERTILIZATION TRIAL PROTOCOL

RUBBER FERTILIZATION

JAMBI province

RAS METHODOLOGY

RAS 1.3/RUBBER FERTILIZATION
TRIAL PROTOCOL

TITLE
Clonal rubber in RAS 1 type agroforestry environment : rubber + secondary forest regrowth
TREATMENT ON RUBBER FERTILIZATION

OBJECTIVE/HYPOTHESE
OBJECTIVES

Rubber is planted at normal planting density of 550/ha in a RAS 1 type trial (cf RAS 1 protocol).

Fertilization of rubber may be a key factor in the trade-off between fertilization/higher cost of establishment, the level of weeding (studied in RAS 1) and the good and fast growth of trees to compete with the natural forest regrowth in the inter-rows.
This trial is aimed to compare 4 amounts of fertilization on clonal rubber in RAS 1 system.

Hypotheses :

In the specific conditions of Jambi , rubber fertilization may be required to obtain a fast growth performance..
Good rubber growth performance may lead to early opening.

EXPECTED OUTPUTS

To produce recommendations on fertilization component of RAS 1 :
- rubber fertilization management required for successful growth of rubber clone in this environment

LOCATION : Jambi, village of Ratau Pandan

YEAR :
planting of rubber : october 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability.

2 replications.
1 farm only.

RAS 1.3/RUBBER FERTILIZATION : pak maowi

A1	*C2*	*not used*	*D2*	*C1*
B2	*D1*	*not used*	*B1*	*A2*

RUBBER
All rep are planted with PB 260

FERTILIZATION
See the treatments

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :

6 weedings ayear , every 2 months, on a regular basis. Local observation and presence of Mikenia or alang² may change that pattern.

INTERCROPPING

No intercropping

ASSOCIATED TREES

No associated trees.

FIELD SIZE per farm
PLOT SIZE : 500 m²
NUMBER OF PLOTS PER REPLICATION : 4 plots
NUMBER OF REPLICATION/farm : 2
OTAL NUMBER OF PLOT PER FARM : 8 plots
NUMBER of FAMS : 1
REPLICATION/FARM SIZE : 4 plots : 4 000 m²

DATA TO BE COLLECTED

Standart data for all RAS 1

RAS 2.2/PALAWIJA-RICE
TRIAL PROTOCOL

RUBBER + associated trees + intercropping

JAMBI

RAS 2.2 TRIAL PROTOCOL
RUBBER + associated trees + intercropping /PALAWIJA/RICE

TITLE
Clonal rubber in agroforestry environment : rubber + selected associated trees (92 trees/ha) + intercropping (rice or palawijas)

OBJECTIVE/HYPOTHESE
OBJECTIVES

- As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate usefull trees (fruits and timber trees) with rubber, at a limited planting density, without subtantial decrease in rubber yield.
- Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees (Durian and timber trees).

Hypotheses

- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generaly a slow growth pattern (in partticular for durian , local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber imature period will create a favourable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2 with rice or palawija intercroping:
- weed management required for successful growth of rubber clone in this environment : 6 weedings per year seem to be sufficient to ensure rubber growth in Jambi : weeding is not a treatment in RAS 2.2 but a confirmation of the target of 6 weeding/year .
- most suitable rice varieties and adapted amount of fertilization.
- the effect of palawijas intercropping on rubber growth and the most adapted palawijas.

LOCATION : Jambi province, Kabupaten Muara Tebo, Kecematan Rantau Pandan, villages of Seppungur (6 rep) and Muara Buat (1 rep)

YEAR :
planting of rubber : December 1995-February 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

NOTE / THE DESIGN OF THIS TRIAL HAS BEEN MODIFIED IN AUGUSTUS 1996

Treatments

plot	rep	associated trees	intercrops	farmer's field	field's plot	clone
1	1	no	alang²/control	adnan1	all field	GT1
2	2	no	alang²/control	adnan1	all field	PB 260
3	1	no	palawija1/rice/ dose 0	Saer	A	GT1
4	2	no	rice/dose 0	Alias	A	GT 1
5	1	no	palawija1	Sabri	A	GT1
6	1	no	no palawija/control 2	Sabran	A	GT1
7	1	no	palawija2	Joni	A	GT 1
8	1	yes	no palawija/control 2	Sabran	B	GT1
9	1	yes	palawija1	Saer	B	GT1
10	2	yes	palawija1	Saer	C	GT1
11	3	yes	Palawija1	Sabri	B	GT1
12	1	yes	rice/dose BPS	Alias	B	GT1
13	1	yes	rice/dose CIFC	Alias	C	GT 1
14	1	yes	palawija2	Joni	A	GT 1

EXPERIMENTAL DESIGN

SUMMARY : 1 treatment : effect on various type of intercropping (with 7 levels) on rubber growth :

1. Control1 : alang² — 2 rep (Adnan1 & 2, plots A)
2. Control2 : no alang², no palawija — 2 rep (Sabran, A & B
3. Rubber + rice/dose 0 : — 2 rep (Alias A/Saer A)
4. Rubber + rice/dose BPS : — 1 rep (Alias B)
5. Rubber + rice/dose CRIFC : — 1 rep (Alias C)
6. Rubber + Palawij1 — 4 rep (Sabri A, Saer B&C, Sabri B)
7. Rubber + palawija2 — 2 rep (Joni A and B)

Randomized block system.
The first 2 years : Associated trees are not a significant treatment as trees are obviously too small to have an impact..
WEEDING : 6 weedings/ year on the row. (100cm on either side of the trees).

Rice experiment statistical analysis will be processed separately. In that case, rice with or without fertilization is just a "system", a level in the treatment 'intercropping'.

RUBBER

All rep are planted with GT1 except one with PB 260 (due to a problem of plant availability in Adnan's plot). Clone is not considered as a treatment.

FERTILIZATION
TCSDP fertilization programme for UREA only for the first 2 years. No fertilization later.
SimplifiedTCSDP based fertilization programme for JAMBI is the following:
IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
UREA		50	50	50	50
SP36		0	0	0	0
KCL		0	0	0	0

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :

6 weedings ayear , every 2 months, on a regular basis.

INTERCROPPING

See the levels.

Palawija are not fertilized.
Rice fertilization is the following :
Dose 0
Dose BPS
Dose CRIFC

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Case 2 : : Durian + duku + other trees

No fertillization.
Weeding : same as for rubber (6 weedings/year).

FIELD SIZE

PLOT SIZE for rubber + intercropping : 1000 m²
PLOT SIZE for rubber + associated trees + intercropping : 1500/2000 m²
NUMBER OF REPLICATION : see the table
REPLICATION/FARM SIZE : 2 500/3000 m²
TOTAL SIZE OF THE TRIAL : 2 ha

DATA TO BE COLLECTED

Standart data for all RAS 2.2 :
RUBBER
- rubber growth measurements : diameter, height and worls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

- Farmer's labour for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield per plot at 14 % weter content

PALAWIJA

- distribution of crops and average planting density
- date of planting for each crop
- date of harvest for each crop
- yields for banana and cassava.
- distribution between self-comsuption and sales

Labour requirements per plot.

RICE EXPERIMENT in RAS 2.2

In Alias and Saer plot A fields :

Rice variety : SAIM (from Sembawa)
Treatment : on fertilization : 3 levels
- dose 0
- dose BPS
- dose CRIFC

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
BPS	100	160	75

"CRIFC fertilization dose" is the dose recommended by CRIFC/Bogor for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
CRIFC	150	220	150

Urea is supplied in 3 times : 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

RAS 2.5 TRIAL PROTOCOL

RUBBER + CINNAMON

JAMBI

RAS METHODOLOGY

RAS 2.5 TRIAL PROTOCOL
RUBBER + CINNAMON

TITLE
Clonal rubber in agroforestry environment : RUBBER + CINNAMON

OBJECTIVE/HYPOTHESE
OBJECTIVES

Cinnamon is a current good crop opportunity for farmers in hilly areas in the piedmont of the Barisan moutains in Central Sumatra. Cinnamon is generaly cut and harvested at 7-8 years old and required a limited shading. The association of rubber and cinnamon valorize the immature period of rubber which profit from weedings of cinnamon. (Rubber is planted at normal planting density of 550/ha . Cinnamon is planted at 3 x 3 meters, 1111 trees per ha).

Hypotheses
- It is expected that rubber growth during immature period will not be affected by cinamon.
- It is expected that cinnamon intercropping and its consequent weeding during rubber imature period will profit to rubber growth.
- Cinnamon should profit froim the sahding of young rubber trees.
- The total shading will limit extension of Imperata in the plot.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.5 :
- the effect of cinnamon on rubber growth.
- the comparison between association and monoculture of each rubber and cinnamon.

LOCATION : Jambi province, Kabupaten Muara Tebo, Kecematan Rantau Pandan,

TRIAL 1 village of Muara Buat (3 rep)
TRIAL 2 SMP Muara Bungo (3 rep)

YEAR :
planting of rubber :
TRIAL 1 /December 1995-February 1996
TRIAL 2/October 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of rubber production monitoring. Cinnamon will be harvested the year 7 or 8.

MATERIALS AND METHOD
Treatments

1. Control: rubber in monoculture, rubber is cropped as in RAS 1 : Weeding on the row. Interrow is occupied by secondary forest regrowth.

2. Rubber + cinnamon: 6 complete weedings/ year.

3 Cinnamon in monoculture

EXPERIMENTAL DESIGN
Randomized block system : 3 rep/trial.

RUBBER

TRIAL 1 / All rep are planted with GT1. 1995
TRIAL 2 / All rep are planted with PB 260. 1996

FERTILIZATION
Simplified TCSDP fertilization programme : 115 grams/tree of SP 36 at planting and 50 grams/tree UREA every 3 months only for the first 2 years. No fertilization later.

SimplifiedTCSDP based fertilization programme for JAMBI is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
UREA		50	50	50	50
SP36		0	0	0	0
KCL		0	0	0	0

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :
6 weedings a year , every 2 months, on a regular basis, on the row for Rubber monoculture and complete for cinnamon and rubber + cinnamon.

CINNAMON

Planting density : 1111 trees/ha :3 x 3 meters.
No fertillization.
Weeding : same as for rubber monoculture (6 complete weedings/year).

FIELD SIZE

PLOT SIZE for rubber + intercropping : 1000 m²/1500 m²
NUMBER OF PLOTS PER REPLICATION : 3 plots
REPLICATION/FARM SIZE : 3000 m²/4500 m²
NUMBER OF REPLICATION = 3
TOTAL SIZE OF THE TRIAL : 0,9 ha/1.35 ha

DATA TO BE COLLECTED

Standart data for all RAS 2.5 :

RUBBER

- rubber growth measurements : diameter, height and worls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labour for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

CINNAMON

- tree growth measurements : girth 6 months after planting for a a sample of 30 trees per plot.

Labour requirements per plot.

RICE EXPERIMENT in RAS 2.5 In 1996/97 at SMPT

2TREATMENTS / RICE VARIETY X RICE FERTILIZATION

TREATMENT 1 : RICE VARIETY
Variety 1 : SAIM (from Sembawa)
Variety 2 : improved variety (Wayararem or Jatiluhur)

TREATMENT 2 : RICE FERTILIZATION
Treatment : on fertilization : 3 levels
- dose 0
- dose BPS
- dose CRIFC

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
BPS	100	160	75

"CRIFC fertilization dose" is the dose recommended by CRIFC/Bogor for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
CRIFC	150	220	150

The rice trial is surimposed on RAS 2.5 for the year of planting only.

DESIGN

REP 1	REP 2	REP 3
RUBBER ONLY **SAIM** **DOSE 0**	RUBBER +CINNAMON **SAIM** **DOSE BPS**	CINNAMON ONLY **WAYARAREM** **DOSE CRIFC**
CINNAMON ONLY **SAIM** **DOSE CRIFC**	RUBBER +CINNAMON **WAYARAREM** **DOSE BPS**	RUBBER ONLY ***no rice***
RUBBER +CINNAMON ***no rice***	RUBBER ONLY **WAYARAREM** **DOSE 0**	CINNAMON ONLY ***no rice***

randomized block system : 2 rep.

Interactions between components of multi-strata Rubber agroforests in Indonesia (initially published by S/E.Williams in 1998)

INTERACTIONS BETWEEN COMPONENTS OF MULTI-STRATA RUBBER AGROFORESTS IN INDONESIA: WHAT CAN BE LEARNT FROM ON-FARM TRIALS

S.E. Williams[1], M. Van Noordwijk[2], E. Penot[2,3], J.R. Healey[1], and F.L. Sinclair[1]
[1] University of Wales, Bangor (UK);[2] ICRAF-S.E.Asia, Bogor (Indonesia);[3] CIRAD-TERA/TH, (France)

Key words: *Hevea brasiliensis*, Indonesia, Sumatra, smallholders, weeding, agroforestry

Introduction

«Jungle rubber» is a traditional multi-strata agroforestry system in which rubber trees grow together with secondary forest, timber and fruit tree species. The system provides a diverse range of timber and non-timber forest products, and environmental benefits due to its forest-like structure, but rubber production per hectare is low due to the use of a non selected planting materiel.

A serie of On-farm trials (OFTs) on various Rubber Agroforestry Systems (RAS, Penot , 1994) were set up to investigate the potential for intensification of traditional «jungle rubber». The trials involved substitution of the older rubber non selected varieties currently used by farmers with high yielding clones. These clones have been selected and grown under monoculture plantation conditions, where their production is up to three to four times that of the farmers' existing local trees. The objective of the experiment was to test a range of low input management practices that were designed to ensure survival and growth of the clones in a highly competitive environment. Clonal rubber was planted in rows which were weeded, and secondary forest allowed to regenerate between rows. Interactions between clonal rubber, secondary forest species and farmer management practices were studied.

Materials and methods

Four weeding management regimes were compared (Table 1). Rubber trees were strip-weeded (1m on either side of the trees), with a range of weeding frequencies chosen to represent management in jungle rubber (B), monoculture plantations (D), and an intermediate level (C). Treatment A was the 'control': the standard management recommendations for the 'TCSDP[1]' monoculture rubber project for smallholders.

The trial was replicated five times in four farmers' fields (one farmer, Saryono, had 2 replications). The farmers received clonal rubber trees, fertiliser, fungicide and technical advice. They were responsible for clearing the field, planting the trees in January 1996, implementing the weeding treatments, selectively pruning regenerated trees in the inter-row that were overtopping the rubber, and managing the legume cover crop (LCC) in Plot A.

Table 1. Planned weeding frequency treatments: scheduled number of weedings in study period

Treatment (Plot)	Inter-row vegetation	No.of weedings
A	Legume cover crop (LCC)	10
B	Secondary forest regrowth	4
C	Secondary forest regrowth	7
D	Secondary forest regrowth	10

[1] TCSDP = Tree Crop Samllholder Development Project, funded by the World bank.

Measurements of rubber growth (height and diameter at 10 cm above the basal graft), and vertebrate pest damage (number of stem breaks per tree) were made every three months. The frequency of weeding actually implemented by the farmers was recorded, along with the time and labour expended on this. Socio-economic data on the farmers was collected by questionnaire survey (Kelfoun *et al*., 1998), and regular informal discussions were held with the farmers in the field regarding experimental management, problems encountered, and their opinions. Statistical analyses of the effects of farmer, weeding frequency, weeding effort and pest damage on rubber growth were conducted using ANOVA and multiple regression in Genstat 5.32.

Results and discussion

The farmer level

Twenty one months after planting, there was a highly significant difference in rubber growth between farmers' fields ($p < 0.001$), but no significant difference between the planned weeding frequency treatments. This was because the farmers did not implement the weedings defined in the protocol (Fig 1).

Also it shows that 10 weedings /year were not necessary and that is there is no difference between 4 and 10, then 4 is OK !!! precise that even ifthe number of weedin is not exactly that planned : then you should put the excta number of weeding per plot : if there is a significant difference OK you are right , if not , then we can suggest without prooving ....

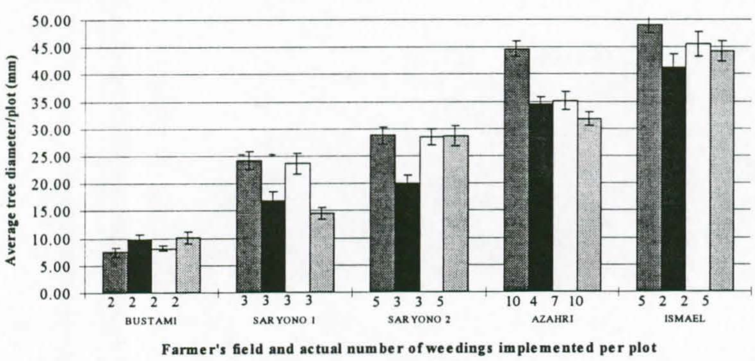


Fig. 1. Average tree diameter/plot for each replication, and actual number of weedings implemented per plot.

Treatment implementation was related to the management effort invested by the farmers in their clonal rubber field, which in turn depended on their socio-economic situation and their strategy in allocating labour and/or cash resources to farming or other activities (Table 2). Bustami, the farmer with the poorest rubber growth (and lowest weeding frequency) had no regular salary, and only intermittent cash income from rattan trading (but he's the chief of the village ....) His priorities were tapping rubber for cash income, and production of irrigated rice for subsistence. He already owned a large area of immature rubber, so intensive management of his experimental plot was not a priority. The inter-row vegetation was not managed and was allowed to grow unchecked. This appeared to be severely competitive with the young rubber. The main effect of the monkeys was that they did destroy all trees regurlarly

The other farmers had regular incomes from government salaries, which provided for their subsistence needs, so for this reason they were able to invest relatively more cash and labour in

their plotsThis situation does not reflect the normal «farmer population» due to the fact that the selection process was based on motivation to apply the trials protocols. rather than representativity
However these resources were still limited, and farmers restricted the amount of weeding to what they perceived as economically justified, and this was usually less than the treatment stipulated. In addition, inadequate weeding and fertilisation resulted in failure of the LCCs.

Table 2. Socio- economic information on participating farmers

Farmer	**Ismael**	**Azahri**	**Saryono**	**Bustami**
Local/immigrant	Local	Local	Immigrant	Local
Occupation	Teacher	Teacher	Soldier	Village Head
Monthly salary (Rp)	386 000	877 000	400 000	-
Monthly income from rubber (Rp)	112 000	-	-	179 000
Other business[1]	None	Shop	Timber trade	Rattan trade
Total land area (ha)	3.5	2.5	1.5	10.5
Productive rubber (ha)	1.5	-	-	2.0
Immature[2] rubber (ha)	-	1.0	-	4.5
Experimental plot (ha)	0.5	0.5	1.0	0.5
Irrigated rice (ha)	-	-	-	0.5

[1] No financial information available (1 US $=2300 Rp, July 1997)
[2] Rubber trees have not attained sufficient girth for tapping

An important result was these three farmers' management of the inter-row vegetation (the 'multi-strata' component):- this was slashed back severely. The farmers' perception was that clonal rubber performs best in monoculture, and they were unwilling to allow secondary forest regrowth to compete with their 'investment'. Cutting the inter-row was for them a greater priority than weeding within the rubber row. In other words, avoiding a possible crop failure by weeding according to the monoculture model was a clear priority of this particular type of «farmers». Another serie of trial in the Seppungur village with «real and more representative farmers» shows a complete different picture.

The landscape level
Depredation by vertebrate pests (shoot-eating monkeys and feral pigs) was a very important factor at the landscape level, the severity of which had not been recognised before implementation of the OFTs by both researchers and farmers. As for weeding management, there were large between-farmer differences in the amount of effort invested in guarding and fencing their fields against pests, and this was reflected in the index of pest damage (average number of stem-breaks per plot) (Fig.2a). A simple linear model of pest damage explained 48% of the variation in rubber stem diameter growth in the trial.

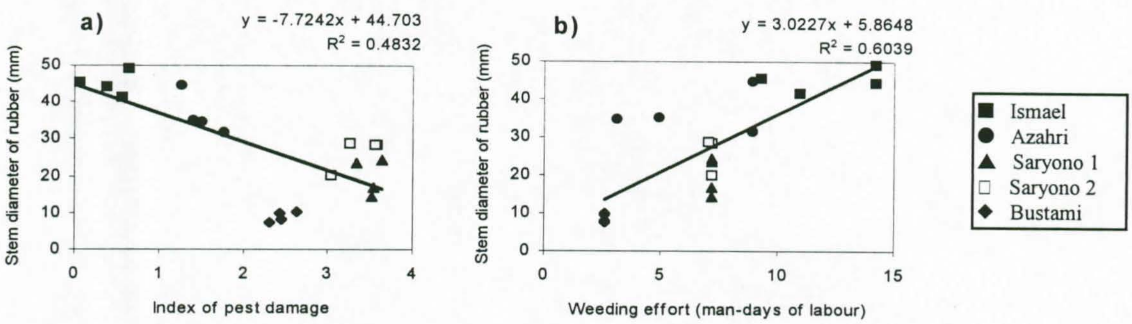


Fig .2 Linear relationship between a) rubber diameter growth and pest damage; b) rubber diameter growth and weeding effort (man-days)

The plot level

Simple regression analyses showed no significant relationship between weeding frequency (number of times a plot was weeded) and rubber diameter growth, but there was also no relationship between weeding frequency and the number of man-days spent weeding that plot. Weeding effort (man-days/plot) explained 60% of variation in diameter growth across farms (Fig. 2b). This can be explained by the different methods of weeding employed by different farmers. These varied in terms of effectiveness, and labour requirements *i.e.* slashing with a machete (Azahri) was quick, but subsequent weed regrowth was also fast. Hoeing (Ismael) was much more labour-intensive but much more effective.

Conclusions

The greatest effect on growth of clonal rubber in this trial was farmer management, which encompassed a number of related factors *i.e.* number of weedings implemented, man-days of labour invested in weeding, and effort expended in protecting trees from pest damage. This in turn was related to the farmers socio-economic situation. The on-farm trial identified two hitherto unrecognised constraints to the adoption of higher cost improved planting material in multi-strata systems: damage by vertebrate pests, and farmers' perceptions of the necessity of intensive management, according to a dominant model that was felt as the best risk management. Although researchers assumed that farmers would prefer to retain their traditional management practices, the reality in this trial was that if farmers were making a step towards intensification, then they were prepared to move the whole way to monoculture, and to abandon their traditional multi-strata system.

The strong effect of farmer indicates that farmer selection for OFTs is critical. For a specific trial objective, a specific 'type' of farmer (for whom the technology is most relevant) should be targeted. Farmers representative of this 'type' could be identified with a brief questionnaire covering socio-economic issues and also technology perception.
In this case , motivation and correct trial implementation was prefered to representativity, which was finnaly , an mistake! The second serie of trials in another village, all representative of local farmers was far more efective.

For OFTs that aim to explore biophysical interactions in multi-strata systems or develop new technologies, the trial should be on farmers' land, but treatment implementation and plot management should be rigidly controlled by the researcher. Once the best technology has been identified in this way, then it should be tested by a suitable selection of farmers in a fully participatory manner. Researchers can then observe farmers' management, relate this to their socio-economic situation, and thus identify the constraints and opportunities for adoption of this technology from the farmers' perspective.

References

Kelfoun A, Penot E and Komardiwan I (1998) Farming systems characterisation and adoption of innovations in Jambi province. In: Penot E, Williams SE, and Boutin D (eds) Proceedings of the Smallholder Rubber Agroforestry Workshop, Bogor, 27-29 September 1997. CIRAD-CP/ICRAF. , Edited in Decembre 1998.

Penot E. Rubber Agroforestry System methodology for on-farm experimentation. ICRAF document paper, Decembre 1994. Bogor.

RUBBER AND RICE FERTILIZATION IN JAMBI

RUBBER FERTILIZATION

DOSE PER HA PER YEAR

		UREA in grammes/tree	SP 36 not used in Jambi	KCL not used in Jambi
total		200	200	160
per 3 months		50	50	40
in Kg/ha/year		110	110	88

For 4 applications in 1996

March, juin, septembre, decembre

RICE FERTILIZATION : BPS DOSE

in kg/ha

		UREA	SP 36	KCL
total		100	140	75
Planting		40	140	75
40 days after		30		
80 days after		30		

RICE FERTILIZATION : CRIFC DOSE

in kg/ha

		UREA	SP 36	KCL
total		150	225	150
Planting		50	225	150
40 days after		50		
80 days after		50		

FERTILISATION PROGRAMME TCSDP
Normal recommended fertilisation

year	1	2	3	4	5
TSP	30	60	87	83	80
or Equivalent Rock phosphate	90	180	270	250	250
Urea	105	90	115	165	80
KCL	0	70	0	70	0

RAS plots characteristics

The GAKINDO/CIRAD/ICRAF SRAP PROJECT

JAMBI PROVINCE

RAS TRIALS PLOT CHARACTERISTICS AND CHOICE BY VILLAGES

FIRST SET OF TRIALS PLANTED IN DECEMBER 1995

MUARA BUAT Farmers	**TYPE** **RAS**	**Rep**	**AREA** **selected** in ha	**Slope**	**Status**	**associated perennials**
EFFENDI	2.5.1	1	0.3	50 %	Belukar 10 years old	presence of Imperata cinnamon
SANDY'PLOT	SPECIFIC		0.8	> 60 %	???	
M NOOR	2.5.1	2	0.3	50 %	half plot slashed in 93 half plot slashed in april 95	cinnamon
ALISRI	2.5.1	3	0.5	75 %	old belukar slashed in 95	Cinnamon
SARYONO 2 rep	1.1/weeding	1 & 2	0.8	> 60 %	secondary forest slashed in april 95	RAS 1 natural forest regrowth
BUSTAMI/K des	1.1/weeding	3	0.4	> 60 %	slashed in april 95 old jungle rubber	RAS 1 natural forest regrowth
TOTAL AREA Number of farmers			**3.1** 5			
RANTAU PANDAN farmers				**Slope**	**Status**	**associated perennials**
YANI	2.2 palawija	5	0.5	20-30° %	Belukar	duku, Rambutan, durian
AZAHRI	1.1/weeding	4	0.4	15 %	10 years	RAS 1 natural forest regrowth
ISMAEL	1.1/weeding	5	0.4	30-40 %	Belukar 5 years	RAS 1 natural forest regrowth
TOTAL AREA Number of farmers			**1.3** 3			
SEPPUNGUR farmers				**intercrop**	**Status**	**associated perennials**
SAER	2.2 palawija/rice	1	0.45	Banana + cassava	old belukar	Durian, duku, rambutan, cempedak no cinnamon
SAPRI	2.2 palawija	2	0.3	Banana + cassava		Durian, duku, rambutan, cempedak no cinnamon
SABRAN	2.2 palawija	3	0.3	Banana + cassava		Durian, duku, rambutan, cempedak no cinnamon
ADNAN1	2.2/alang²	6	0.25	rice	Old jungle rubber S&B in 1994, alang²	Durian + duku
ADNAN2	2.2/alang²	7	0.25	rice	Old jungle rubber S&B in 1994, alang²	Durian + duku
ALIAS	2.2/rice	4	0.3	rice	belukar 3 years	Durian + duku
TOTAL AREA Number of farmers			**1.85** 5			

TOTAL NUMBER OF farmers 13

NEW TRIALS PLANTING IN OCTOBER 1996

The GAKINDO/CIRAD/ICRAF SRAP PROJECT

JAMBI PROVINCE

RAS TRIALS PLOT CHARACTERISTICS AND CHOICE BY VILLAGES

SECOND SET OF TRIALS PLANTED IN OCTOBER 1996

SEPPUNGUR	TYPE RAS	REP	AREA selected	Slope	Status	associated perennials
			in ha			
Farmers 6 rep						
Sarhoni	1.1/weeding	1	0.4	flat	Old jungle rubber	no
Zulkifli	1.1/weeding	2	0.4	flat	Old jungle rubber	no
Aljufri	1.1/weeding	3	0.4	flat	Old jungle rubber + Coffee	no
Eman	1.1/weeding	4	0.4	flat	Old jungle rubber + Coffee	no
Azwar	1.1/weeding	5	0.4	flat	Old jungle rubber	no
Abdul Roni 1	1.1/weeding	6	0.4	10 %	Old jungle rubber	no
TOTAL			**2.4**			
SEPPUNGUR	clone comparison RAS 1.2/CC					
Taridi	RAS 1.2/CC	1	0.8		Secondary forest	no
Abdul Roni 2	RAS 1.2/CC	2	0.8	flat	Old jungle rubber	no
TOTAL			**1.6**			
M BUAT/R PANDAN						
Mawi Sutan 1	1.3/rubber fertilization	SPECIFIC	0.4	30-50 %	Old jungle rubber	no
Yusuf	RAS 1.2/CC/half	3/half	0.8	50-70 %	Secondary forest	no
Harahap	RAS 1.2/CC/half half	3/half	0.8	60-80 %	Secondary forest	no
M Dur	RAS 1.2/CC	4	0.8	30 %	Old jungle rubber	no
Mawi Sutan 2	RAS 1.2/CC	5	0.8	flat to 20 %	Old jungle rubber	no
TOTAL VILLAGE			**3.6**			
TOTAL			**7.6**			

The GAKINDO/CIRAD/ICRAF SRAP PROJECT

JAMBI PROVINCE

RAS TRIALS PLOT CHARACTERISTICS AND CHOICE BY VILLAGES

SECOND SET OF TRIALS PLANTED IN OCTOBER 1996

MUARA BUAT Farmers	TYPE RAS	Rep	AREA selected in ha	Slope	Status	associated perennials
STMP	RAS 2.5	1	0.45	flat	alang²/old rubber	cinnamon
STMP	RAS 2.5	2	0.45	flat	alang²/old rubber	cinnamon
STMP	RAS 2.5	3	0.45	flat	alang²/old rubber	cinnamon
TOTAL						

NEW TRIALS PLANTING IN OCTOBER 1996

JAMBI PROVINCE

FARMERS	TYPE RAS	RICE VARIETY	Rice planting date	Rubber planting date 1996	Pohon lain + PTC planting date	AREA selected in ha		TYPE OF CLONES	NUMBER OF STUMPS per field 550
Farmers									
Sarhoni	1.1/weeding	no rice		october	no	0.4		PB 260	220
Zulkifli	1.1/weeding	no rice		october	no	0.4		PB 260	220
Aljufri	1.1/weeding	no rice		october	no	0.4		PB 260	220
Eman	1.1/weeding	no rice		october	no	0.4		PB 260	220
Azwar	1.1/weeding	no rice		october	no	0.4		PB 260	220
Abdul Roni 1	1.1/weeding	no rice		october	no	0.4		PB 260	220
									1320
	clone compariso RAS 1.2/CC								
Taridi	RAS 1.2/CC	no rice		october	no	0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
Abdul Roni 2	RAS 1.2/CC					0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
Mawi Sutan 1	1.3/rubber fertilization	no rice		october	no	0.4		PB 260	220
Yusuf	RAS 1.2/CC/half	no rice		october	no	0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
Harahap	RAS 1.2/CC/half half	no rice		october	no	0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
M Dur	RAS 1.2/CC	no rice		october	no	0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
Mawi Sutan 2	RAS 1.2/CC	no rice		october	no	0.8		PB 260	88
								RRIC 100	88
								BPM 1	88
								RRIM 600	88
								seedlings	88
								total	440
						total		PB 260	2,068
								RRIC 100	528
								BPM 1	528
								RRIM 600	528
								seedlings	528

RICE EXPERIMENT ON RAS 2.5 in october/February 96/97 in SMP

FARMERS	TYPE RAS	RICE VARIETY	Rice planting date in 1995	Rubber planting date	Pohon lain + PTC planting date	AREA selected in ha	NB OF TREES PER FIELD 550	TYPE OF CLONES	NUMBER OF STUMPS per field 550
STMP	RAS 2.5	siam/wayararem	oct 96	oct 96	oct 96	0.45		PB 260	165
STMP	RAS 2.5	siam/wayararem	oct 96	oct 96	oct 96	0.45		PB 260	165
STMP	RAS 2.5	siam/wayararem	oct 96	oct 96	oct 96	0.45		PB 260	165

Associated trees planted in RAS 2

ASSOCIATED TREES COMPOSITION IN RAS 2.2 IN SEPPUNGUR
Jambi province

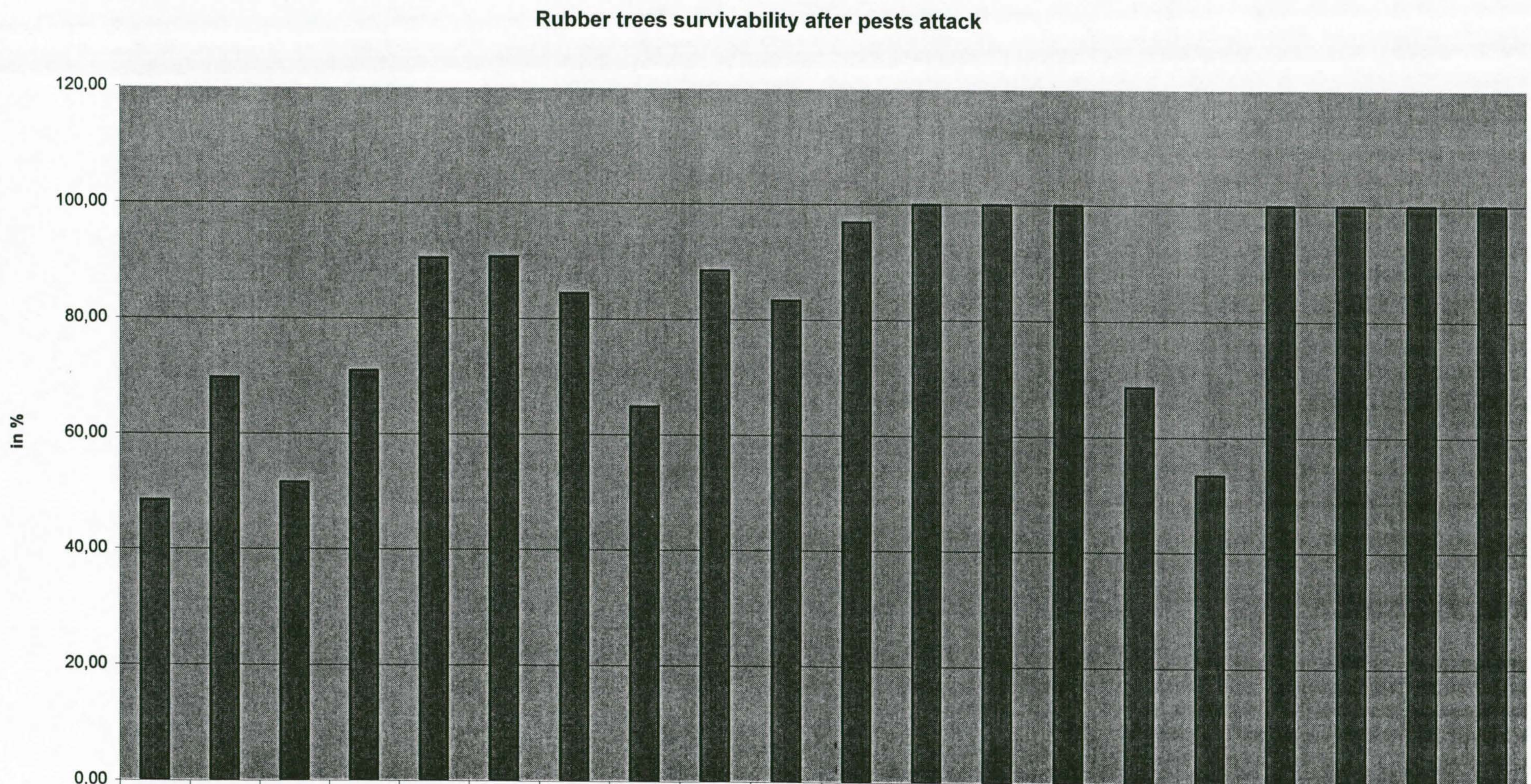
For group I (Sapri, Saer and Sabran) : the composition of trees is the following :
Durian, nangka, rambutan, cempedak.
For group II (Alias and the 2 plots of Adnan) : the composition of trees is the following :
Durian and duku.

DISTRIBUTION OF ASSOCAITED TREES IN RAS 2.2 in SEPPUNGUR

		FARMERS							AVAILABLE	To be
SPECIES	**per/ha**	**Saer**	**Sapri**	**Sabran**	**Alias**	**ADnan1**	**Adnan2**	**TOTAL**	**Saer/sabri/sabra**	**purchased**
Plot area		**0.45**	**0.3**	**0.3**	**0.3**	**0.25**	**0.25**	**required**		
Durian	18	6	3	3		3	3	18	35	
nangka	40	9	8	8				25	104	
rambutan	22	7	5	5				17	96	
cempedak	6	2	2	2				6	16	
mango	6	1	2	2				5	6	
total	92	25	20	20	0	3	3	71	257	
									Alias	
durian	18				4	3	3	10	25	
duku	74				16	9	9	34	16	18
total	92	0	0	0	20	12	12	44	41	

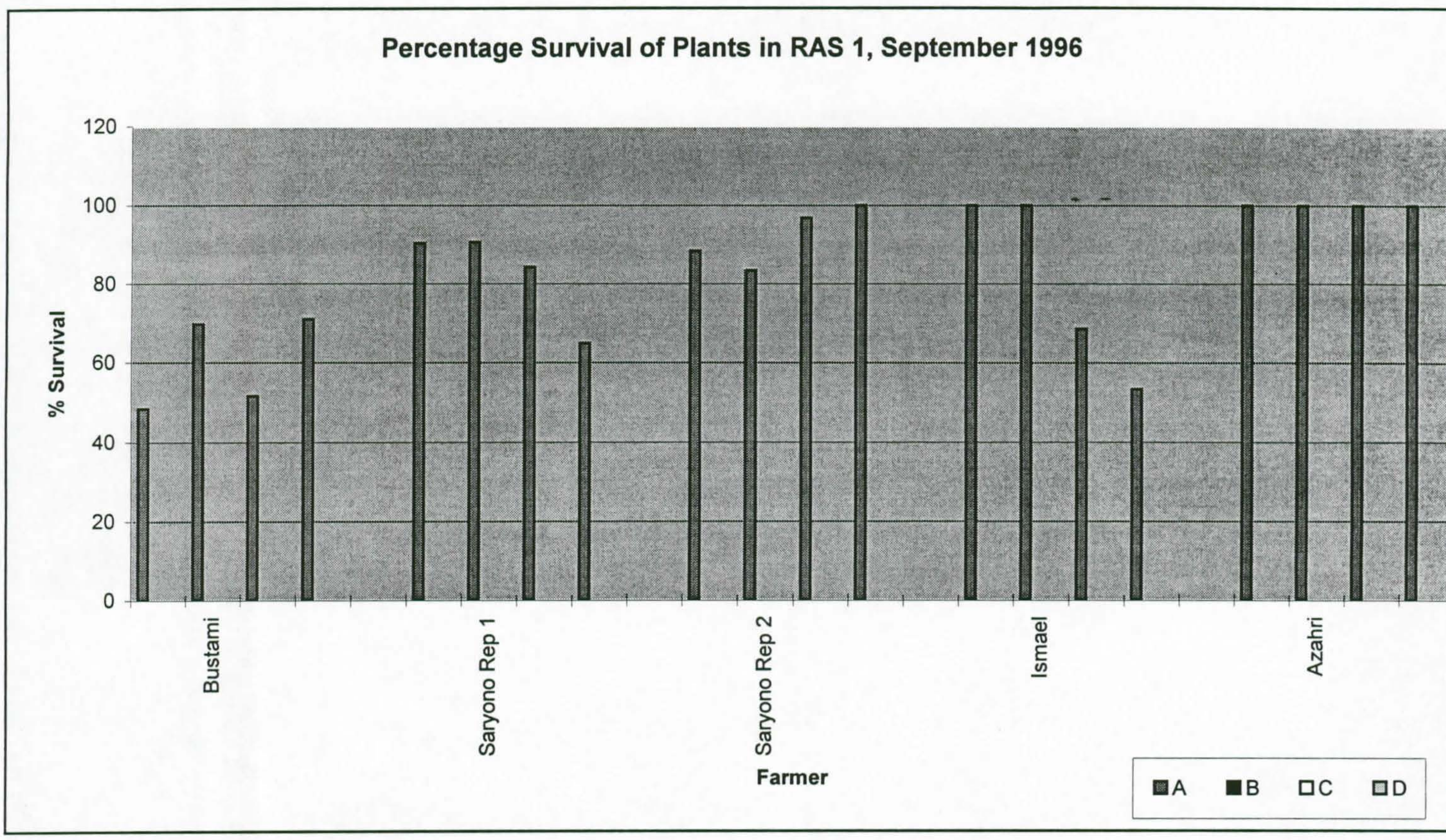
We purchased 30 duku (including a security stock or 12 trees)
Saer gives 6 durian to Adnan.
Other trees may be planted in the plot borders

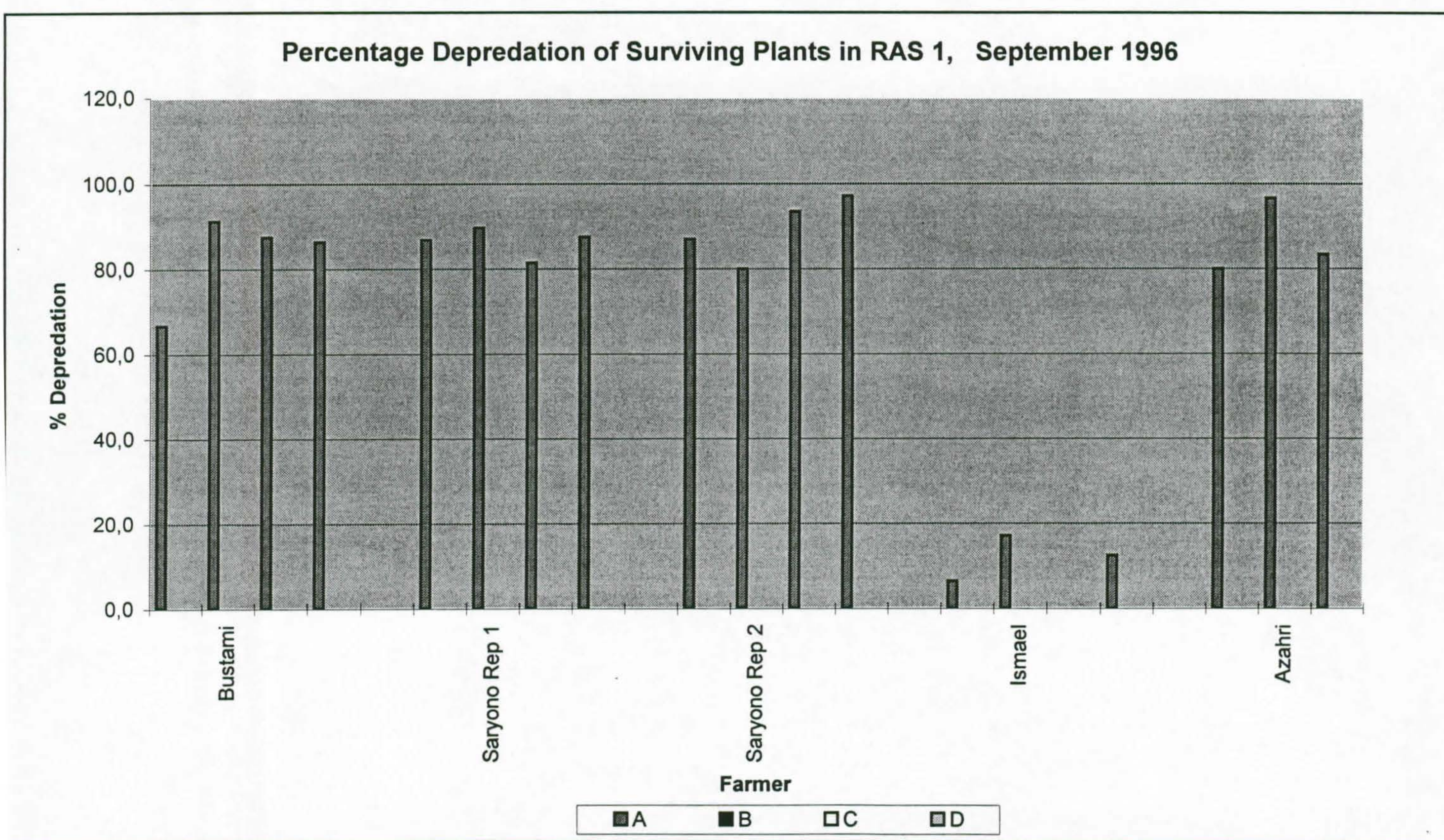
Effect of pests (monkeys and pigs) on rubber growth in RAS 1 in Jambi



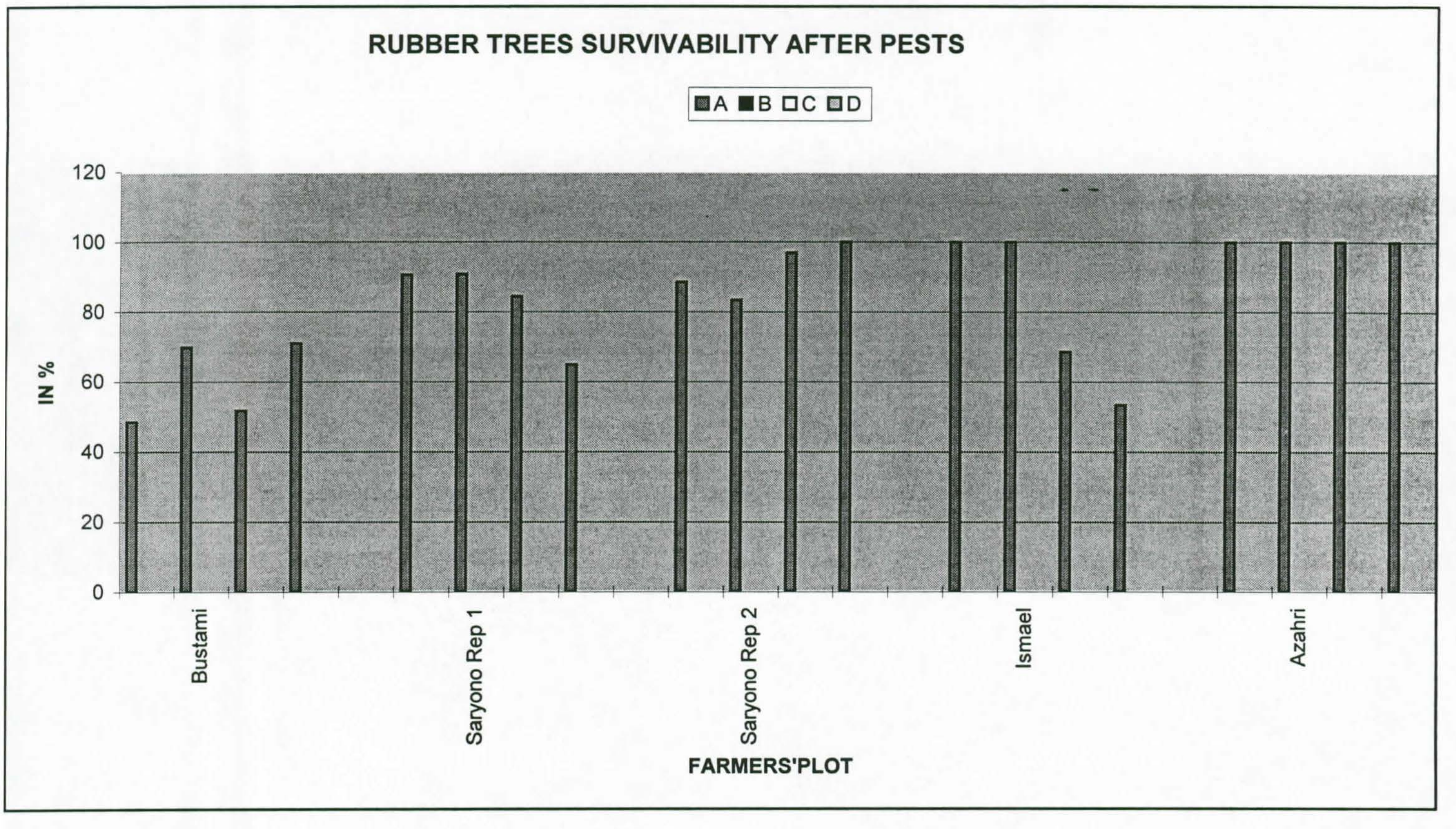
	A Bustami	B Bustami	C Bustami	D Bustami	A Saryono Rep 1	B Saryono Rep 1	C Saryono Rep 1	D Saryono Rep 1	A Saryono Rep 2	B Saryono Rep 2	C Saryono Rep 2	D Saryono Rep 2	A Ismael	B Ismael	C Ismael *	D Ismael *	A Azahri	B Azahri	C Azahri	D Azahri
■ Series1	48,39	69,70	51,61	70,97	90,48	90,70	84,38	64,86	88,46	83,33	96,88	100,00	100,00	100,00	68,57	53,33	100,00	100,00	100,00	100,00

farmers plot :


Percentage Survival of Plants in RAS 1, September 1996
120
100
80
60
40
20
0
% Survival
Bustami
Saryono Rep 1
Saryono Rep 2
Ismael
Azahri
Farmer
A
B
C
D



Percentage Depredation of Surviving Plants in RAS 1, September 1996
120,0
100,0
80,0
60,0
40,0
20,0
0,0
% Depredation
Bustami
Saryono Rep 1
Saryono Rep 2
Ismael
Azahri
Farmer
A
B
C
D


RUBBER TREES SURVIVABILITY AFTER PESTS
A B C D
120
100
80
60
40
20
0
IN %
Bustami
Saryono Rep 1
Saryono Rep 2
Ismael
Azahri
FARMERS'PLOT

Frequency of weeding in RAS 1.1 Rantau Pandan/Muara Buat

Jambi province

EFFECT OF PESTS ON RUBBER GROWTH IN RUBBER AGROFORESTRY SYSTEMS

DATE / September 1996.

Farmer	Plot	No. Plants Dead	No. Plants Alive	No.Live Plants Depredated	% Live Plants Depredated	No. of Live Plants 1 Stem Break	2 Stem Breaks	3 Stem Breaks	4 Stem Breaks
Bustami	A	16	15	10	66,67	9	1	0	0
Bustami	B	10	23	21	91,30	14	7	0	0
Bustami	C	15	16	14	87,50	8	2	3	1
Bustami	D	9	22	19	86,36	12	6	0	1
Saryono Rep 1	A	4	38	33	86,84	14	13	6	0
Saryono Rep 1	B	4	39	36	92,31	20	11	5	0
Saryono Rep 1	C	5	27	22	81,48	14	7	1	0
Saryono Rep 1	D	13	24	21	87,50	7	11	1	2
Saryono Rep 2	A	6	46	40	86,96	20	13	6	1
Saryono Rep 2	B	7	35	28	80,00	19	8	0	1
Saryono Rep 2	C	1	31	29	93,55	6	12	9	2
Saryono Rep 2	D	0	35	34	97,14	10	19	5	0
Ismael	A	0	31	2	6,45	2	0	0	0
Ismael	B	0	35	6	17,14	6	0	0	0
Ismael *	C	11	24	0	0,00	0	0	0	0
Ismael *	D	14	16	2	12,50	2	0	0	0
Azahri	A	0	30	24	80,00	18	6	0	0
Azahri	B	0	30	29	96,67	25	4	0	0
Azahri	C	0	30	25	83,33	20	5	0	0
Azahri	D	0	32	27	84,38	24	3	0	0

* 'Plants lost due to landslide

Plot

A	Interrow: Legume cover crop	Rubber row:	Strip weeding 1m each side of trees, 9 times/year
B	Interrow: Belukar	Rubber row:	Strip weeding 1m each side of trees, 3 times/year
C	Interrow: Belukar	Rubber row:	Strip weeding 1m each side of trees, 6 times/year
D	Interrow: Belukar	Rubber row:	Strip weeding 1m each side of trees, 9 times/year

Protection by farmers

Farmer	Fence	Guarding
Bustami	Plastic sheeting ('2 sides of field only)	No. Very rarely goes to field
Saryono	No	No. Very rarely goes to field
Ismael	Barbed wire	Yes. Every day, early morning and late evening, with air rifle
Azahri	Barbed wire	No. Simpai are not a problem: field is close to the village, houses with dogs nearby. Reported depredation here is from goats which got over the fence a few times.

RAS 1 WEEDING

First year of treatment implementation: March 96 - February 97

SUMMARY

Plot/Rep	Saryono 1	Saryono 2	Azahri	Ismael	Bustami
A	2	4	9	5	2
B	2	2	3	2	2
C	2	2	6	2	2
D	2	4	9	5	2

DETAILS

Rep	A		B		C		D	
	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual
Sary.1	11/03/96	12-18/03/96	11/03/96	12-18/03/96	11/03/96	12-18/03/96	11/03/96	12-18/03/96
	19/04/96	-					19/04/96	-
					06/05/96	-		
	29/05/96	-					29/05/96	-
			17/06/96	-				
	08/07/96	-			08/07/96	-	08/07/96	-
	17/08/96	-					17/08/96	-
					09/09/96	-		
		20/09/96		20/09/96		20/09/96		20/09/96
	26/09/96	-					26/09/96	-
	05/11/96	-	05/11/96	-	05/11/96	-	05/11/96	-
	15/12/96						15/12/96	
					06/01/97			
	31/01/97	-					31/01/97	-
Sary. 2	11/03/96	12-18/03/96	11/03/96	12-18/03/96	11/03/96	12-18/03/96	11/03/96	12-18/03/96
	19/04/96	-					19/04/96	-
					06/05/96	-		
	29/05/96	-					29/05/96	-
			17/06/96	-				
	08/07/96	-			08/07/96	-	08/07/96	-
	17/08/96	-					17/08/96	-
					09/09/96	-		
		20/09/96		20/09/96		20/09/96		20/09/96
	26/09/96	-					26/09/96	-
	05/11/96	05/11/96	05/11/96	-	05/11/96	-	05/11/96	05/11/96
	15/12/96						15/12/96	
					06/01/97			
	31/01/97	14-17/02/97					31/01/97	14-17/02/97
Azahri	11/03/96	13-24/03/96	11/03/96	13-24/03/96	11/03/96	13-24/03/96	11/03/96	13-24/03/96
	19/04/96	19-20/4/96					19/04/96	19-20/4/96
					06/05/96	06/05/96		
	29/05/96	29/05/96					29/05/96	29/05/96
			17/06/96	14-30/06/96				
	08/07/96	07-08/07/96			08/07/96	07-08/07/96	08/07/96	07-08/07/96
	17/08/96	11-26/08/96					17/08/96	11-26/08/96
					09/09/96	06-09/9/96		
	26/09/96	22-29/09/96					26/09/96	22-29/09/96
	05/11/96	04-17/11/96	05/11/96	04-17/11/96	05/11/96	04-17/11/96	05/11/96	04-17/11/96
	15/12/96	14-17, 26/12/96					15/12/96	14-17, 26/12/96
					06/01/97	05-06/01/97		
	31/01/97	13-14/01/97					31/01/97	13-14/01/97

Rep	A		B		C		D	
	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual
Ismael	11/03/96	09-12/03/96	11/03/96	09-12/03/96	11/03/96	09-12/03/96	11/03/96	09-12/03/96
	19/04/96	19-20/04/96					19/04/96	19-20/04/96
					06/05/96	06-09/05/96		
	29/05/96	29/05/96					29/05/96	29/05/96
			17/06/96	17/06/96				
	08/07/96	08/07/96			08/07/96	08/07/96	08/07/96	08/07/96
	17/08/96	19-20/08/96					17/08/96	19-20/08/96
					09/09/96	-		
	26/09/96	-					26/09/96	-
	05/11/96	-	05/11/96	-	05/11/96	-	05/11/96	-
	15/12/96	-					15/12/96	-
					06/01/97	-		
	31/01/97	-					31/01/97	-
Bustami	11/03/96	24/03/96	11/03/96	24/03/96	11/03/96	24/03/96	11/03/96	24/03/96
	19/04/96	-					19/04/96	-
					06/05/96			
	29/05/96	29/05/96		29/05/96		29/05/96	29/05/96	29/05/96
			17/06/96	-				
	08/07/96	-			08/07/96	-	08/07/96	-
	17/08/96	-					17/08/96	-
		-			09/09/96	-		
	26/09/96						26/09/96	-
	05/11/96	-	05/11/96	-	05/11/96	-	05/11/96	-
	15/12/96	RTO		RTO		RTO	15/12/96	RTO
					06/01/97	-		
	31/01/97	-					31/01/97	-

NOTES

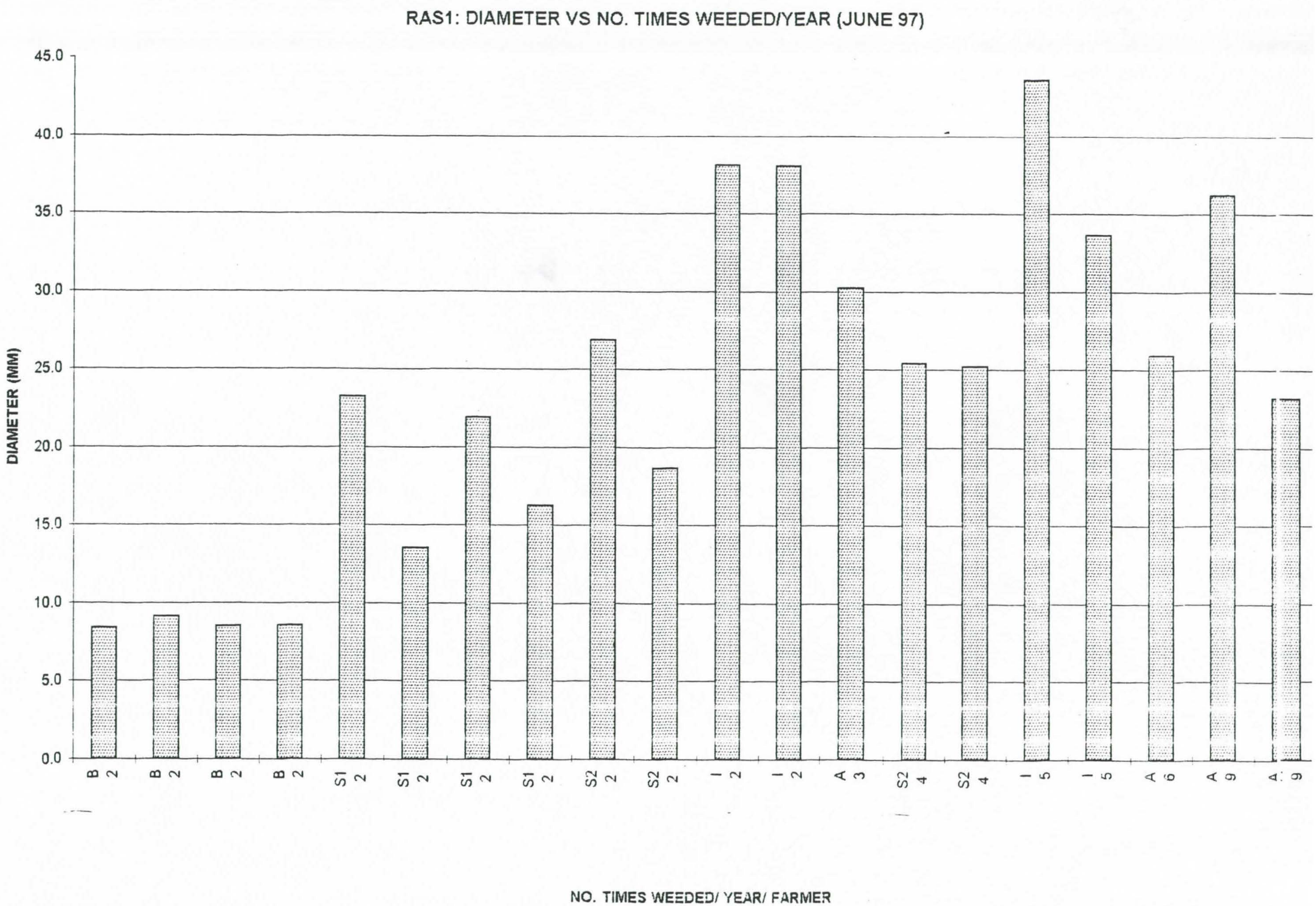
Bustami: RTO Replanted Trees Only (circle weeded within individual fences)

Saryono: slashed interrow (tall trees) twice. Refuses to weed more often as thinks simpai are more of a problem if field is clean.

Ismael: slashed interrow (trees) twice, grass and LCCs cut by someone for buffalo feed (plots A, C, D)
No work done since landslide (end August 96).

1st weeding of 2nd year

Rep	A		B		C		D	
	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual
Saryo.1	12/03/97	01-05/03/97	03/03/97	01-05/03/97	03/03/97	01-05/03/97	12/03/97	01-05/03/97
Saryo.2	12/03/97	01-05/03/97	03/03/97	01-05/03/97	03/03/97	01-05/03/97	12/03/97	01-05/03/97
Azahri	12/03/97	13-? /03/97	03/03/97	13-? /03/97	03/03/97	13-? /03/97	12/03/97	13-? /03/97
Ismael	12/03/97	-	03/03/97	-	03/03/97	-	12/03/97	-
Bustami	12/03/97	15/03/96	03/03/97	-	03/03/97	-	12/03/97	15/03/96


RAS1: DIAMETER VS NO. TIMES WEEDED/YEAR (JUNE 97)
DIAMETER (MM)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
B 2
B 2
B 2
B 2
S1 2
S1 2
S1 2
S1 2
S2 2
S2 2
I 2
I 2
A 3
S2 4
S2 4
I 5
I 5
A 6
A 9
A 9
NO. TIMES WEEDED/ YEAR/ FARMER

RAS 1

Rubber growth summary RAS 1.1

JAMBI PROVINCE : RUBBER GROWTH DATA SUMMARY
Prepared by gede Wibawa

FOR RAS 1.1

Farmer	Plot	2/97 Diameter	5/97 Diameter	8/97 Diameter	increase 5-2 D. Diam	8-5 D. Diam
Sahroni	A	11.6	20.0	32.2	8.40	12.20
	B	13.9	24.1	35.3	10.27	11.13
	C	13.8	27.3	34.2	13.52	6.84
	D	13.8	24.5	35.5	10.74	10.94
Eman	A	12.8	22.3	31.4	9.47	9.13
	B	11.4	17.1	25.7	5.73	8.54
	C	15.2	20.0	28.9	4.80	8.90
	D	12.2	19.5	29.7	7.32	10.18
A Roni	A	8.2	17.7	30.0	9.53	12.25
	B	8.6	16.7	26.8	8.08	10.08
	C	7.2	16.0	27.3	8.80	11.28
	D	8.3	17.3	29.8	9.01	12.51
Zulkifli	A	12.4	22.7	30.6	10.29	7.93
	B	10.5	19.6	29.9	9.09	10.30
	C	11.2	20.3	22.2	9.10	1.90
	D	12.4	22.0	32.9	9.60	10.89
Aljupri	A	15.1	25.9	26.7	10.88	0.75
	B	14.5	23.1	24.8	8.58	1.70
	C	13.5	23.8	25.1	10.26	1.36
	D	14.4	24.2	25.9	9.84	1.68
Azwar	A	8.7	15.8	21.8	7.10	6.00
	B	8.9	17.0	25.9	8.10	8.90
	C	9.7	17.6	25.0	7.90	7.40
	D	10.5	20.2	28.7	9.70	8.50

DATA PERTAMBAHAN PER TIGA BULAN
1=FEBRUARI - MEI 1997, 2= MEI - AGUSTUS 1997

NAME	Period	Treatment	D.Height	D.Stem Diam.	Total Whorls	Whorls	Lost Whorls
Aljupri	1	A	358.1	35.8	7.9	3.3	4.6
		B	479.0	41.1	8.3	3.5	5.2
		C	375.0	33.4	7.1	3.5	3.6
		D	348.0	33.1	5.6	2.7	3.0
	2	A	154.2	13.5	0.5	-0.5	1.2
		B	149.8	16.3	4.6	0.7	4.3
		C	165.9	17.4	4.3	-0.4	5.1
		D	168.2	19.9	3.2	0.6	2.8
A Roni	1	A	111.2	9.5	2.0	0.7	0.5
		B	163.3	13.9	2.1	2.0	1.7
		C	100.0	8.8	1.7	0.0	0.8
		D	108.6	9.0	1.9	0.4	0.8
	2	A	107.6	12.3	2.0	0.5	1.6
		B	89.3	10.1	1.3	0.1	1.3
		C	98.7	11.3	1.8	0.4	1.4
		D	102.3	12.5	1.9	0.3	1.6
Azwar	1	A	163.1	13.8	1.8	0.8	1.0
		B	294.7	26.8	3.1	2.6	3.7
		C	157.6	15.3	2.3	0.8	1.5
		D	211.2	19.1	1.9	0.2	2.2
	2	A	67.2	11.9	2.9	-0.4	3.4
		B	154.5	17.9	4.8	0.3	4.3
		C	134.7	14.5	1.7	-0.3	1.9
		D	160.1	16.8	1.4	0.2	0.5
EMAN	1	A	221.7	18.6	2.2	0.0	2.4
		B	363.6	25.6	5.0	2.7	5.0
		C	237.5	9.3	2.5	0.9	1.2
		D	232.6	14.4	3.5	0.9	2.2
	2	A	182.1	18.0	1.6	1.0	0.7
		B	149.5	16.8	3.8	2.9	0.9
		C	147.4	17.5	4.5	3.4	1.3
		D	199.2	20.1	2.0	0.6	1.4
Sahroni	1	A	92.8	16.3	2.4	0.8	1.4
		B	210.1	37.9	5.6	1.4	5.4
		C	111.4	26.2	2.0	0.6	1.3
		D	124.8	20.8	3.0	1.5	1.4
	2	A	67.1	23.6	2.5	0.0	2.2
		B	111.6	21.5	2.9	0.3	2.5
		C	89.5	13.2	3.0	0.5	2.4
		D	98.2	21.2	2.1	-0.2	2.3
Zulkifli	1	A	106.7	10.3	1.5	0.3	1.0
		B	177.0	15.8	3.2	0.7	2.6
		C	95.8	9.1	1.2	0.9	0.2
		D	106.6	9.6	1.4	0.6	0.8
	2	A	73.5	7.9	2.3	0.3	1.9
		B	101.7	10.3	1.8	0.1	1.7
		C	90.8	1.9	1.5	-0.1	1.5
		D	99.5	10.9	2.4	0.3	2.0

JAMBI PROVINCE : RUBBER GROWTH DATA SUMMARY FOR RAS 1.1

Prepared by gede Wibawa

Farmer	Plot		Height	Diameter	Total Whorls	Whorls	Lost Whorls
Aljupri	A	Average	152.6552	15.0552	4.5862	3.1034	1.4828
21/2/97		Stdev.	26.3320	2.3794	0.5680	0.6179	0.6877
RAS 1.1	B	Average	144.5667	14.4967	4.2000	2.1667	2.0333
		Stdev.	38.5027	3.2639	0.7144	0.5921	0.6149
	C	Average	143.3133	13.5133	4.8000	2.8333	2.0345
		Stdev.	39.8830	2.3630	1.0954	0.7915	0.8230
	D	Average	145.5517	14.4000	4.6552	2.7931	1.9643
		Stdev.	45.6716	4.3554	0.9738	0.4913	0.8812
Aljupri	A	Average	510.7586	50.8517	12.4828	6.4483	6.0345
23/5/97		Stdev.	63.8474	3.2882	0.7209	0.5276	0.7527
	B	Average	493.5000	45.3089	10.4286	5.5000	5.2308
		Stdev.	67.1632	5.5869	1.2488	0.6118	0.6288
	C	Average	518.3103	46.8879	11.8966	6.3103	5.5862
		Stdev.	34.4156	3.7917	0.8653	0.4913	0.8481
	D	Average	493.5333	47.5267	10.2667	5.5000	4.9310
		Stdev.	82.3004	6.2291	1.3309	0.8469	0.8290
Aljupri	A	Average	664.9667	64.3633	12.9333	5.9000	7.2759
19/8/97		Stdev.	93.9543	8.3901	1.5222	0.6433	0.9218
	B	Average	643.2667	61.6583	15.0333	6.1667	9.5000
		Stdev.	92.1860	8.2497	1.8782	0.8743	0.9315
	C	Average	684.1667	64.2750	16.2000	5.9000	10.6552
		Stdev.	69.2271	6.0755	1.5466	0.8305	1.1501
	D	Average	661.7000	67.4717	13.5000	6.0667	7.6897
		Stdev.	81.1463	6.1962	1.2243	0.6074	0.9002
Aljupri	A	Average	664.9667	52.2982	12.9333	5.9000	7.2759
19/8/97i		Stdev	93.9543	3.4438	1.5222	0.6433	0.9218
	B	Average	643.2667	48.5929	15.0333	6.1667	9.5000
		Stdev	92.1860	3.8591	1.8782	0.8743	0.9315
	C	Average	684.1667	49.4466	16.2000	5.9000	10.6552
		Stdev	69.2271	2.7692	1.5466	0.8305	1.1501
	D	Average	661.7000	50.9400	13.5000	6.0667	7.6897
		Stdev	81.1463	4.8142	1.2243	0.6074	0.9002

NAME	Period	Treatmen	D.Height	D.Stem Diam.	Total Whorls	Whorls	Lost Whorls
Aljupri	1	A	358.1	35.8	7.9	3.3	4.6
		B	479.0	41.1	8.3	3.5	5.2
		C	375.0	33.4	7.1	3.5	3.6
		D	348.0	33.1	5.6	2.7	3.0
	2	A	154.2	13.5	0.5	-0.5	1.2
		B	149.8	16.3	4.6	0.7	4.3
		C	165.9	17.4	4.3	-0.4	5.1
		D	168.2	19.9	3.2	0.6	2.8

A Roni	A	Average	72.5333	8.2000	2.9667	2.6667	1.1250
20/2/97		Stdev	18.7078	1.9255	0.4138	0.6609	0.3536
RAS 1.1	B	Average	60.9000	8.5950	2.7333	2.6667	1.0000
		Stdev	10.7906	6.8773	0.4498	0.4795	0.0000
	C	Average	54.8333	7.2033	2.9000	2.8000	1.0000
		Stdev	16.3582	1.2604	0.3051	0.4068	0.0000
	D	Average	67.7667	8.2667	2.9667	2.7000	1.0000
		Stdev	15.7583	1.0708	0.1826	0.5350	0.0000
A Roni	A	Average	183.7667	17.7333	5.0000	3.4000	1.6552
21/5/97		Stdev	37.9834	2.9313	0.6948	0.6215	0.6139
	B	Average	171.9333	16.6700	4.7333	3.0000	1.7000
		Stdev	33.6615	2.8668	0.5833	0.4549	0.4661
	C	Average	154.8000	16.0033	4.6000	2.8000	1.8000
		Stdev	29.7859	3.2087	0.5632	0.4842	0.4068
	D	Average	176.3333	17.2800	4.8667	3.1333	1.7667
		Stdev	26.2170	2.7714	0.4342	0.5074	0.5683
A Roni	A	Average	291.3333	29.9883	7.0333	3.8667	3.2759
20/8/97		Stdev	52.8461	3.4168	1.1290	0.8604	0.4549
	B	Average	261.2000	26.7500	6.0333	3.0667	2.9667
		Stdev	47.0937	3.1179	0.8087	0.4498	0.6687
	C	Average	253.5333	27.2800	6.4000	3.2333	3.1667
		Stdev	50.1307	3.7528	0.8550	0.5683	0.7466
	D	Average	278.6667	29.7933	6.7667	3.4000	3.3667
		Stdev	35.5065	2.7113	0.7739	0.6747	0.5561
A Roni	A	Average	291.3333	19.7017	7.0333	3.8667	3.2759
20/8/97i		Stdev	52.8461	3.1574	1.1290	0.8604	0.4549
	B	Average	261.2000	20.1917	6.0333	3.0667	2.9667
		Stdev	47.0937	2.7133	0.8087	0.4498	0.6687
	C	Average	253.5333	19.8833	6.4000	3.2333	3.1667
		Stdev	50.1307	3.4200	0.8550	0.5683	0.7466
	D	Average	278.6667	21.2383	6.7667	3.4000	3.3667
		Stdev	35.5065	2.7394	0.7739	0.6747	0.5561

A Roni	1	A	111.23	9.53	2.03	0.73	0.53
		B	163.34	13.94	2.07	2.00	1.70
		C	99.97	8.80	1.70	0.00	0.80
		D	108.57	9.01	1.90	0.43	0.77
	2	A	107.57	12.25	2.03	0.47	1.62
		B	89.27	10.08	1.30	0.07	1.27
		C	98.73	11.28	1.80	0.43	1.37
		D	102.33	12.51	1.90	0.27	1.60

Azwar	A	Average	127.2069	17.1448	6.3448	4.3103	2.9500
21/2/97		Stdev	31.2014	2.6645	1.2721	0.7736	0.5130
RAS 1.1	B	Average	145.7857	17.2250	6.9286	5.0000	2.3478
		Stdev	28.8381	2.1944	1.0099	0.9306	0.4289
	C	Average	162.4444	19.0315	6.9259	4.7037	2.7273
		Stdev	36.5658	3.2195	0.9740	0.6360	0.5903
	D	Average	183.6296	20.7704	8.3333	5.2222	3.2308
		Stdev	39.0661	3.0191	0.8006	0.6293	0.5616
Azwar	A	Average	290.3214	30.9375	8.1481	5.0741	3.9524
23/5/97		Stdev	70.7928	5.4206	1.5861	0.8439	0.8367
	B	Average	311.9333	33.7717	8.1000	4.9000	3.6923
		Stdev	72.6070	5.6774	1.5071	0.7761	0.7594
	C	Average	320.0357	34.3000	9.2143	5.4643	4.2000
		Stdev	76.5310	6.5899	1.4365	0.6862	0.8000
	D	Average	394.8667	39.8466	10.2000	5.4667	5.4615
		Stdev	81.5856	6.1325	1.9134	0.8976	0.7104
Azwar	A	Average	357.5000	42.8086	11.0714	4.6667	7.3600
20/8/97		Stdev	90.8035	7.3930	2.2617	0.8884	1.2342
	B	Average	466.4000	51.6250	12.9000	5.1667	8.0000
		Stdev	94.0125	7.2991	1.9780	0.8550	0.9315
	C	Average	454.7333	48.8333	10.9000	5.1667	6.1429
		Stdev	103.0110	8.4835	1.6955	0.8087	0.8483
	D	Average	554.9333	56.6500	11.5850	5.6207	5.9643
		Stdev	93.3262	6.8005	1.5222	0.7894	0.5762
Azwar	A	Average	357.5000	32.3138	11.0714	4.6667	7.3600
20/8/97i		Stdev	90.8035	4.8166	2.2617	0.8884	1.2342
	B	Average	466.4000	37.4083	12.9000	5.1667	8.0000
		Stdev	94.0125	5.1648	1.9780	0.8550	0.9315
	C	Average	454.7333	36.7100	10.9000	5.1667	6.1429
		Stdev	103.0110	5.4483	1.6955	0.8087	0.8483
	D	Average	554.9333	42.8517	11.5850	5.6207	5.9643
		Stdev	93.3262	5.1600	1.5222	0.7894	0.5762

Azwar	1	A	163.11	13.79	1.80	0.76	1.00
		B	294.71	26.84	3.10	2.55	3.69
		C	157.59	15.27	2.29	0.76	1.47
		D	211.24	19.08	1.87	0.24	2.23
	2	A	67.18	11.87	2.92	-0.41	3.41
		B	154.47	17.85	4.80	0.27	4.31
		C	134.70	14.53	1.69	-0.30	1.94
		D	160.07	16.80	1.38	0.15	0.50

Eman	A	Average	248.4828	25.2293	9.5517	5.8276	3.7241
21/2/97		Stdev	30.6605	2.5895	0.6930	0.4988	0.6732
RAS 1.1	B	Average	208.0000	22.3731	8.0385	5.1154	3.0400
		Stdev	25.5191	2.0552	0.8162	0.6972	0.5831
	C	Average	208.0000	30.2379	8.3793	5.0345	3.7308
		Stdev	32.6329	13.9935	1.1849	0.6859	0.8162
	D	Average	186.4667	23.9233	7.6667	5.4667	2.6400
		Stdev	32.5449	8.6232	0.6074	0.6261	0.4899
Eman	A	Average	470.1667	43.7950	11.8000	5.8333	6.1724
23/5/97		Stdev	61.9190	4.9049	1.3646	0.7184	0.9533
	B	Average	385.9333	33.6300	10.0667	5.7333	5.0000
		Stdev	74.1736	5.1321	1.5477	0.7397	0.6469
	C	Average	445.5172	39.5207	10.8621	5.9310	4.9310
		Stdev	56.4447	4.3922	1.2711	0.9056	0.9111
	D	Average	419.0667	38.3633	11.1667	6.3333	4.8333
		Stdev	50.3832	3.8837	0.9223	0.7279	0.8976
Eman	A	Average	652.2667	61.8367	13.4333	6.7931	6.8667
19/8/97		Stdev	73.2486	5.8881	1.2058	0.6859	0.7311
	B	Average	535.4667	50.4183	13.8667	8.6000	5.8519
		Stdev	97.7083	7.5109	2.1162	1.3767	0.7338
	C	Average	592.9333	57.0517	15.3667	9.3333	6.2414
		Stdev	73.6698	6.7175	1.6060	1.3374	0.4682
	D	Average	618.3000	58.4533	13.1333	6.9000	6.2333
		Stdev	57.2455	4.6403	0.8841	0.6823	0.5307
Eman	A	Average	652.2667	45.7183	13.4333	6.7931	6.8667
19/8/97i		Stdev	73.2486	4.3004	1.2058	0.6859	0.7311
	B	Average	535.4667	40.6630	13.8667	8.6000	5.8519
		Stdev	97.7083	4.6738	2.1162	1.3767	0.7338
	C	Average	592.9333	44.2310	15.3667	9.3333	6.2414
		Stdev	73.6698	4.0679	1.6060	1.3374	0.4682
	D	Average	618.3000	45.2283	13.1333	6.9000	6.2333
		Stdev	57.2455	3.7411	0.8841	0.6823	0.5307

Eman	1	A	221.68	18.57	2.25	0.01	2.45
		B	363.56	25.59	4.95	2.69	5.00
		C	237.52	9.28	2.48	0.90	1.20
		D	232.60	14.44	3.50	0.87	2.19
	2	A	182.10	18.04	1.63	0.96	0.69
		B	149.53	16.79	3.80	2.87	0.85
		C	147.42	17.53	4.50	3.40	1.31
		D	199.23	20.09	1.97	0.57	1.40

Sahroni 21/2/97 **RAS 1.1**	A	Average	102.6897	22.4367	7.6000	4.6667	3.3846	Sahroni	1	A	92.78	16.28	2.40	0.82	1.44
		Stdev	38.7262	3.4360	0.7527	0.6823	0.7234			B	210.10	37.87	5.61	1.41	5.38
	B	Average	122.8667	26.7967	8.8387	4.9677	4.1379			C	111.41	26.20	2.05	0.62	1.26
		Stdev	43.3134	3.7982	1.1043	0.7279	0.7052			D	124.80	20.79	2.97	1.55	1.35
	C	Average	124.6897	26.6867	8.5333	4.7333	4.0714		2	A	67.13	23.60	2.53	0.05	2.17
		Stdev	31.4950	3.1542	1.0862	0.7361	0.8916			B	111.57	21.54	2.90	0.32	2.49
	D	Average	127.4667	26.6452	8.7742	4.5806	4.1935			C	89.47	13.23	3.03	0.51	2.41
		Stdev	29.7063	3.0370	0.7303	0.4901	0.7466			D	98.17	21.18	2.06	-0.19	2.32
Sahroni 23/5/97	A	Average	195.4667	38.7129	10.0000	5.4839	4.8276								
		Stdev	75.0088	6.3879	1.5775	0.8339	0.7454								
	B	Average	236.9000	46.7065	10.5806	5.5484	5.3793								
		Stdev	66.0561	6.5574	1.3060	0.6288	0.9172								
	C	Average	236.1000	52.8903	10.5806	5.3548	5.3333								
		Stdev	58.2304	19.7644	1.1366	0.5683	0.8305								
	D	Average	252.2667	47.4323	11.7419	6.1290	5.5484								
		Stdev	44.4266	4.5729	1.0807	0.6477	0.8193								
Sahroni 19/8/97	A	Average	262.6000	62.3161	12.5333	5.5333	7.0000								
		Stdev	94.8086	21.8159	1.4546	0.7894	0.8625								
	B	Average	348.4667	68.2419	13.4839	5.8710	7.8667								
		Stdev	76.5816	6.0200	1.0662	0.1826	0.7527								
	C	Average	325.5667	66.1226	13.6129	5.8667	7.7419								
		Stdev	81.6830	6.2076	0.9994	0.6258	0.7878								
	D	Average	350.4333	68.6161	13.8065	5.9355	7.8710								
		Stdev	59.4328	5.1210	1.1958	0.5833	0.9072								
Sahroni 19/8/97i	A	Average	262.6000	40.3667	12.5333	5.5333	7.0000								
		Stdev	94.8086	5.9385	1.4546	0.7894	0.8625								
	B	Average	348.4667	49.9774	13.4839	5.8710	7.8667								
		Stdev	76.5816	5.7020	1.0662	0.1826	0.7527								
	C	Average	325.5667	50.4452	13.6129	5.8667	7.7419								
		Stdev	81.6830	5.0661	0.9994	0.6258	0.7878								
	D	Average	350.4333	52.2355	13.8065	5.9355	7.8710								
		Stdev	59.4328	3.6826	1.1958	0.5833	0.9072								

Zulkifli	A	Average	104.3448	12.3759	4.0690	2.5517	1.8333	Zulkifli	1	A	106.655	10.28747126	1.497701149	0.34828	1.02380952
21/2/97		Stdev	25.8488	2.9577	0.9611	0.7361	0.7020			B	176.976	15.81305419	3.236453202	0.72742	2.59259259
RAS 1.1	B	Average	91.7500	10.5411	3.8214	2.1429	2.2381			C	95.7793	9.099942529	1.175862069	0.93218	0.24876847
		Stdev	38.0853	3.4424	1.4670	0.6506	0.7684			D	106.607	9.602873563	1.359770115	0.55172	0.81185185
	C	Average	102.6207	11.1517	4.7241	2.0345	2.7857		2	A	73.5	7.93	2.3	0.3	1.86699507
		Stdev	23.2293	2.5219	1.2217	0.4211	0.8759			B	101.683	10.29551724	1.820689655	0.06782	1.71775223
	D	Average	101.7931	12.3638	4.2069	2.4483	2.0400			C	90.7667	1.901666667	1.479310345	-0.1046	1.48275862
		Stdev	38.5305	4.0134	1.2358	0.7361	0.7895			D	99.5333	10.88666667	2.433333333	0.33333	1.97573436
Zulkifli	A	Average	211.0000	22.6633	5.5667	2.9000	2.8571								
23/5/97		Stdev	57.3363	5.9079	1.4782	0.8030	0.7559								
	B	Average	187.5172	19.6345	5.3793	2.9655	2.5926								
		Stdev	68.9325	5.3341	1.6128	0.7311	1.1184								
	C	Average	198.4000	20.2517	5.9000	2.9667	3.0345								
		Stdev	58.7576	5.1661	1.4704	0.4901	1.0516								
	D	Average	208.4000	21.9667	5.5667	3.0000	2.8519								
		Stdev	79.1287	7.5637	1.6333	0.7428	0.7181								
Zulkifli	A	Average	284.5000	30.5933	7.8667	3.2000	4.7241								
19/8/97		Stdev	76.8670	7.4677	1.8520	0.8052	1.1618								
	B	Average	289.2000	29.9300	7.2000	3.0333	4.3103								
		Stdev	77.9900	6.9167	1.8644	0.8899	1.1681								
	C	Average	289.1667	22.1533	7.3793	2.8621	4.5172								
		Stdev	69.8324	5.0645	1.3205	0.5158	1.1838								
	D	Average	307.9333	32.8533	8.0000	3.3333	4.8276								
		Stdev	91.8255	7.5978	1.8754	0.8023	1.1973								
Zulkifli	A	Average	284.5000	26.4796	7.8667	3.2000	4.7241								
19/8/97i		Stdev	76.8670	18.9863	1.8520	0.8052	1.1618								
	B	Average	289.2000	22.3321	7.2000	3.0333	4.3103								
		Stdev	77.9900	4.2405	1.8644	0.8899	1.1681								
	C	Average	289.1667	22.1533	7.3793	2.8621	4.5172								
		Stdev	69.8324	5.0589	1.3205	0.5158	1.1838								
	D	Average	307.9333	24.2217	8.0000	3.3333	4.8276								
		Stdev	91.8255	5.9311	1.8754	0.8023	1.1973								

Rubber growth summary RAS 1.2

JAMBI PROVINCE : RUBBER GROWTH DATA SUMMARY FOR RAS 1.2

Prepared by gede Wibawa

Farmers	Plot	Clone	Height	Diameter	Total whorls	Whorls	Lost who	
H_Dur	A(3x)	RRIC 100	46.5500	8.8775	2.11	1.33	1.40	1
	A(3x)	BPM 1	79.9692	13.1038	4.00	2.11	2.13	2
	A(3x)	RRIM 600	86.0000	10.7318	3.10	1.65	1.93	3
	A(3x)	PB 260	97.8846	10.5923	5.58	1.00	5.00	4
	A(3x)	Seedling	69.4231	10.9635	3.14	2.14	1.71	5
	B(6x)	RRIC 100	73.4762	8.8421	2.24	1.44	1.60	6
	B(6x)	BPM 1	36.5000	5.8917	2.63	1.13	2.00	7
	B(6x)	RRIM 600	98.5714	11.1214	3.65	2.42	1.88	8
	B(6x)	PB 260	97.7143	12.6056	3.35	1.96	1.78	9
	B(6x)	Seedling						10
M Lutan	A(3x)	RRIC 100	159.0667	17.1183	4.07	2.43	1.63	11
	A(3x)	BPM 1	178.4000	69.5414	5.48	3.41	2.14	12
	A(3x)	RRIM 600	218.0000	20.6063	5.58	3.42	2.60	13
	A(3x)	PB 260	250.1667	29.0150	5.72	3.14	2.59	14
	A(3x)	Seedling	150.7667	12.8450	6.34	2.71	3.72	15
	B(6x)	RRIC 100	121.7500	16.0196	3.43	2.04	1.77	16
	B(6x)	BPM 1	198.2333	23.1833	5.40	3.55	2.27	17
	B(6x)	RRIM 600	213.0333	22.6133	5.37	3.13	2.56	18
	B(6x)	PB 260	276.9667	30.1233	6.00	3.10	2.90	19
	B(6x)	Seedling	161.1667	13.7667	6.23	2.67	3.69	20
Taridi	A(3x)	RRIC 100	282.9667	25.1350	6.67	3.47	3.20	21
	A(3x)	BPM 1	399.4667	29.6567	8.57	5.67	2.90	22
	A(3x)	RRIM 600	282.6000	24.1200	6.43	3.50	2.93	23
	A(3x)	PB 260	396.3000	25.8633	7.13	3.50	3.63	24
	A(3x)	Seedling	211.6333	13.4983	6.30	2.73	3.69	25
	B(6x)	RRIC 100	287.5333	26.9467	8.60	4.23	4.50	26
	B(6x)	BPM 1	390.9000	29.7517	9.03	5.80	3.27	27
	B(6x)	RRIM 600	288.1667	26.3617	8.70	4.17	4.50	28
	B(6x)	PB 260	404.7333	27.7767	8.80	4.20	4.60	29
	B(6x)	Seedling	219.5000	19.6650	8.47	2.93	5.33	30
Yusuf	A(3x)	RRIC 100	270.9091	27.6068	6.55	3.41	3.14	31
	A(3x)	BPM 1	161.0417	18.3250	5.57	2.78	2.78	32
	A(3x)	RRIM 600	141.2500	16.5025	4.90	2.75	2.26	33
	A(3x)	PB 260	262.7727	28.9250	5.41	2.50	3.00	34
	A(3x)	Seedling	293.0909	30.1023	9.27	3.09	6.18	35
	B(6x)	RRIC 100	296.9545	41.1841	6.95	3.91	3.05	36
	B(6x)	BPM 1	127.0000	16.0543	4.43	2.62	2.00	37
	B(6x)	RRIM 600	164.2917	17.0917	5.21	2.79	2.42	38
	B(6x)	PB 260	347.0909	39.2614	6.59	3.41	3.18	39
	B(6x)	Seedling	194.4545	21.1523	7.00	2.32	4.68	40
	B(6x)	Seedling	101.1429	8.9275	5.63	2.47	3.33	40
A Roni	A(3x)	Seedling	125.8824	13.0059	5.18	2.35	2.88	41
	A(3x)	RRIC 100	250.0000	33.8633	6.57	3.43	3.10	42
	A(3x)	BPM 1	330.2667	34.4917	7.97	5.40	2.53	43
	A(3x)	RRIM 600	419.6000	33.2050	7.87	4.50	3.37	44
	A(3x)	PB 260	289.0000	29.2083	6.03	3.13	2.90	45
	A(3x)	Seedling	179.6333	17.8350	5.53	2.43	3.44	46
	B(6x)	RRIC 100	250.3133	33.8717	7.83	4.83	3.00	47
	B(6x)	BPM 1	325.1667	34.5383	8.50	5.70	2.80	48
	B(6x)	RRIM 600	435.2667	34.4583	8.47	5.03	3.59	49
	B(6x)	PB 260	345.1000	34.1717	7.37	4.20	3.17	50
	B(6x)	Seedling	156.9000	14.2783	7.33	3.37	4.24	51

JAMBI PROVINCE : RUBBER GROWTH DATA SUMMARY   FOR RAS 1.2

Prepared by gede Wibawa

Farmers	Plot	Clon		Height	Diameter	Total whorls	Whorls	Lost whorls	
H_Dur	A(3x)	RRIC 100	Average	42.0000	6.4771	1.64	1.44	1.00	1
26/2/97			Stdev.	17.3013	2.0963	0.64	0.58	0.00	
	A(3x)	BPM 1	Average	44.7778	8.3648	1.81	1.62	1.00	2
			Stdev.	17.6337	9.2469	0.57	0.57	0.00	
	A(3x)	RRIM 600	Average	49.4375	6.1844	2.21	1.29	1.30	3
			Stdev.	18.9278	1.6780	0.58	0.47	0.48	
	A(3x)	BPM 1	Average	50.1111	8.1630	2.00	1.70	1.00	4
			Stdev.	17.3833	1.7051	0.55	0.61	0.00	
	A(3x)	Seedling	Average						5
			Stdev.						
	B(6x)	PB 260	Average	59.0357	8.0661	2.18	1.79	1.22	9
			Stdev.	17.3813	1.7475	0.55	0.63	0.44	
	B(6x)	RRIM 600	Average	44.3182	5.9227	2.05	1.43	1.18	8
			Stdev.	13.2930	1.4404	0.59	0.51	0.40	
	B(6x)	RRIC 100	Average	41.5833	5.8625	2.14	1.59	1.20	6
			Stdev.	21.1473	2.3909	0.83	0.73	0.42	
	B(6x)	Seedling	Average						10
			Stdev.						
	B(6x)	BPM 1	Average	42.4400	6.4875	1.64	1.44	1.00	7
			Stdev.	17.6023	2.1015	0.64	0.58	0.00	
H_Dur	A(3x)	RRIC 100	Average	43.5000	9.2538	1.83	1.42	1.11	11
22/5/97			Stdev.	20.7870	7.7085	1.03	0.61	0.33	
	A(3x)	BPM 1	Average	81.4286	10.0446	2.85	2.04	1.00	12
			Stdev.	39.6545	3.1933	1.22	0.96	0.00	
	A(3x)	RRIM 600	Average	70.9310	8.3966	2.33	1.67	1.20	13
			Stdev.	35.4108	2.2710	1.24	0.73	0.41	
	A(3x)	Seedling	Average	152.5357	12.3286	6.35	1.00	5.43	15
			Stdev.	54.5483	1.3316	2.06	0.00	2.04	
	A(3x)	PB 260	Average	39.1111	6.9778	1.69	1.20	1.22	14
			Stdev.	15.5991	1.9669	0.84	0.56	0.44	
	B(6x)	PB 260	Average	91.1034	10.9603	2.76	2.00	1.16	19
			Stdev.	42.2157	3.1806	1.06	1.17	0.37	
	B(6x)	RRIM 600	Average	64.9310	7.7362	2.31	1.00	1.00	18
			Stdev.	29.2464	2.2847	1.07	0.00	0.00	
	B(6x)	RRIC 100	Average	50.3571	7.9000	1.89	1.26	1.31	16
			Stdev.	28.8870	2.7307	0.97	0.53	0.63	
	B(6x)	Seedling	Average	118.1333	10.1467	5.41	1.35	5.06	20
			Stdev.	51.6432	2.1118	4.62	0.79	2.63	
	B(6x)	BPM 1	Average	56.9655	9.7759	2.18	1.44	1.31	17
			Stdev.	29.1554	2.9313	1.09	0.64	0.48	
H_Dur	A(3x)	RRIC 100	Average	46.5500	8.8775	2.11	1.33	1.40	21
28/8/97			Stdev.	15.2228	3.0872	0.78	0.50	0.55	
	A(3x)	BPM 1	Average	79.9692	13.1038	4.00	2.11	2.13	22
			Stdev.	57.2426	4.9697	1.75	0.96	1.02	
	A(3x)	RRIM 600	Average	86.0000	10.7318	3.10	1.65	1.93	23
			Stdev.	43.8374	3.5445	1.41	0.88	0.80	
	A(3x)	PB 260	Average	97.8846	10.5923	5.58	1.00	5.00	24
			Stdev.	46.4348	3.3751	2.57	0.00	2.24	
	A(3x)	Seedling	Average	69.4231	10.9635	3.14	2.14	1.71	25
			Stdev.	40.6253	4.5239	1.31	1.06	0.83	
	B(6x)	PB 260	Average	97.7143	12.6056	3.35	1.96	1.78	29
			Stdev.	60.0894	5.4491	1.58	0.86	0.81	
	B(6x)	RRIM 600	Average	98.5714	11.1214	3.65	2.42	1.88	28
			Stdev.	50.3590	4.4890	1.38	0.64	0.78	
	B(6x)	RRIC 100	Average	73.4762	8.8421	2.24	1.44	1.60	26
			Stdev.	96.8481	4.1087	1.03	0.62	0.70	
	B(6x)	Seedling	Average						30
			Stdev.						
	B(6x)	BPM 1	Average	36.5000	5.8917	2.63	1.13	2.00	27
			Stdev.	20.2327	2.2611	1.30	0.35	0.63	
H_Dur	A(3x)	RRIC 100	Average	46.5500		2.11	1.33	1.40	31
28/8/97I			Stdev.	15.2228		0.78	0.50	0.55	
	A(3x)	BPM 1	Average	79.9692	11.7222	4.00	2.11	2.13	32
			Stdev.	57.2426	2.1420	1.75	0.96	1.02	
	A(3x)	RRIM 600	Average	86.0000	9.9417	3.10	1.65	1.81	33
			Stdev.	43.8374	3.0164	1.41	0.88	0.91	
	A(3x)	PB 260	Average	97.8846	7.0750	5.58	1.00	5.00	34
			Stdev.	46.4348	2.1132	2.57	0.00	2.24	
	A(3x)	Seedling	Average	69.4231	10.3875	3.14	2.14	1.71	35
			Stdev.	40.6253	3.3701	1.31	1.06	0.83	
	B(6x)	PB 260	Average	101.3333	10.4958	3.35	1.96	1.78	39
			Stdev.	58.0411	2.9072	1.58	0.86	0.81	
	B(6x)	RRIM 600	Average	98.5714	9.3036	3.65	2.42	1.88	38
			Stdev.	50.3590	2.0575	1.38	0.64	0.78	
	B(6x)	RRIC 100	Average	73.4762	8.1000	2.24	1.44	1.60	36
			Stdev.	96.8481		1.03	0.62	0.70	
	B(6x)	Seedling	Average						40
			Stdev.						
	B(6x)	BPM 1	Average	36.5000		2.63	1.13	2.00	37
			Stdev.	20.2327		1.30	0.35	0.63	

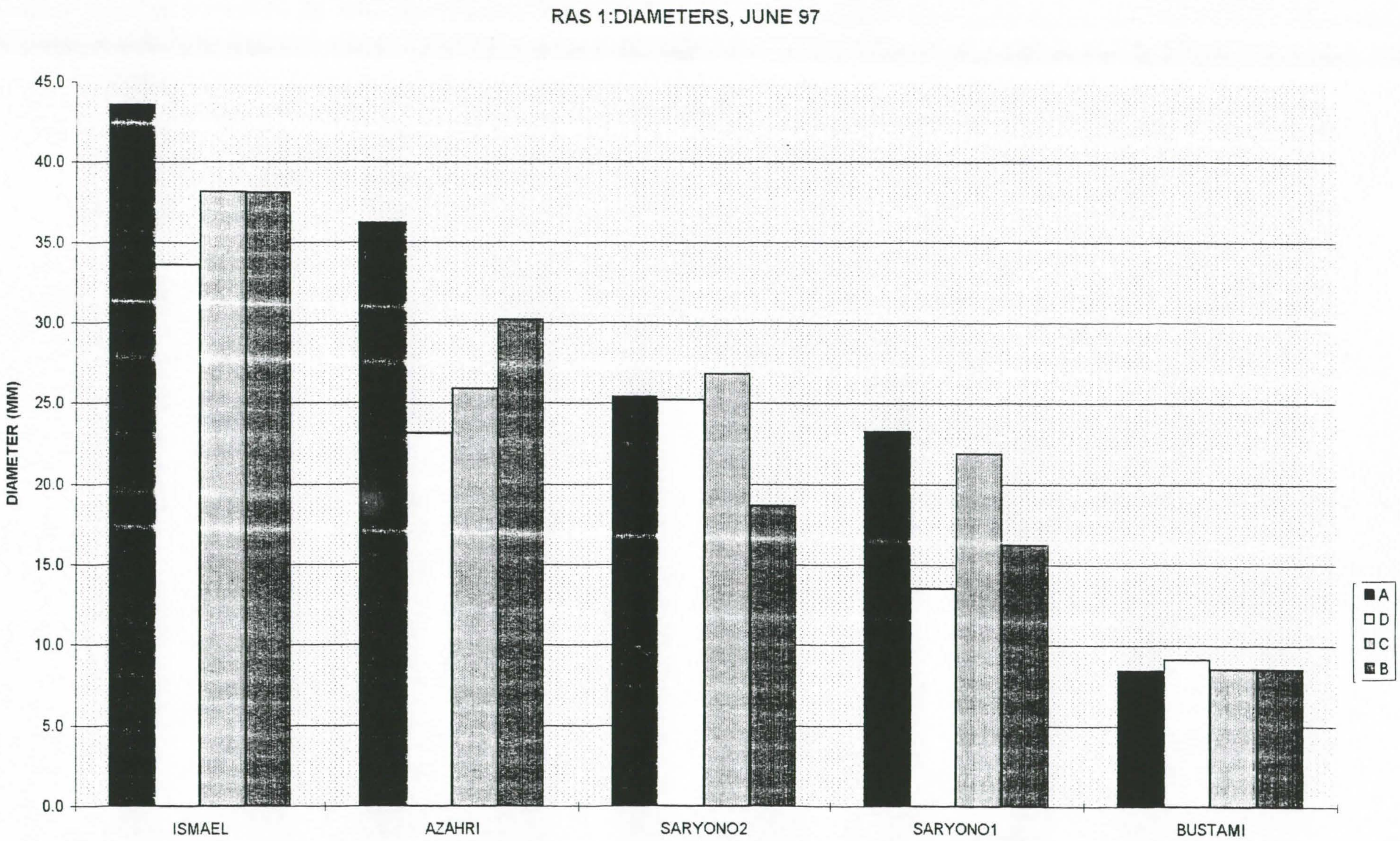
Harahap 26/2/97	A(3x)	Seedling	Average	25.1818	3.3000	2.00	1.33	2.00	
			Stdev.	16.0494	0.9201	1.18	0.48	0.76	
	A(3x)	RRIM 600	Average	58.4615	7.9577	2.38	1.69	1.00	
			Stdev.	21.5933	1.5660	0.51	0.75	0.00	
	A(3x)	BPM 1	Average	68.2917	9.6750	2.79	2.19	1.00	
			Stdev.	23.5805	2.5823	0.66	0.68	0.00	
	A(6x)	Seedling	Average	24.6842	3.3233	2.16	1.83	1.60	
			Stdev.	13.1193	0.8183	1.34	1.15	0.89	
	A(6x)	RRIM 600	Average	63.5000	9.8667	2.38	1.96	1.11	
			Stdev.	20.5617	2.3436	0.49	0.62	0.33	
	A(6x)	BPM 1	Average	59.4000	8.5000	2.40	1.80	1.00	
			Stdev.	23.5145	2.5630	0.70	0.42	0.00	
Harahap 24/5/97	A(3x)	Seedling	Average	68.3333	6.5583	4.00	2.74	1.45	
			Stdev.	15.7664	1.4940	0.74	0.96	0.69	
	A(3x)	RRIM 600	Average	96.2000	11.7850	3.45	2.90	1.10	
			Stdev.	34.6677	2.2291	0.89	0.72	0.32	
	A(3x)	BPM 1	Average	100.7500	13.3896	3.83	2.42	1.48	
			Stdev.	32.7577	3.3407	0.82	0.78	0.59	
	A(6x)	Seedling	Average	71.6818	8.1091	4.41	2.14	2.60	
			Stdev.	31.7556	2.7834	1.47	0.71	0.99	
	A(6x)	RRIM 600	Average	108.5833	15.7438	3.67	2.33	1.45	
			Stdev.	46.6485	5.5332	1.05	0.76	0.74	
	A(6x)	BPM 1	Average	81.3333	10.4771	3.04	2.54	1.09	
			Stdev.	38.2255	3.5404	0.95	0.78	0.30	
Harahap 26/8/97	A(3x)	Seedling	Average	125.8824	13.0059	5.18	2.35	2.88	
			Stdev.	33.7988	2.8148	1.51	0.70	0.81	
	A(3x)	RRIM 600	Average	141.2500	16.5025	4.90	2.75	2.26	
			Stdev.	42.6699	3.5449	1.17	0.64	0.73	
	A(3x)	BPM 1	Average	161.0417	18.3250	5.57	2.78	2.78	
			Stdev.	37.8251	3.3290	0.79	0.42	0.80	
	A(6x)	Seedling	Average	101.1429	8.9275	5.63	2.47	3.33	
			Stdev.	51.8221	3.7851	1.61	0.84	1.03	
	A(6x)	RRIM 600	Average	164.2917	17.0917	5.21	2.79	2.42	
			Stdev.	63.2156	5.2368	1.14	0.93	0.83	
	A(6x)	BPM 1	Average	127.0000	16.0543	4.43	2.62	2.00	
			Stdev.	67.5020	6.5533	1.43	1.02	0.73	
Harahap 26/8/97I	A(3x)	Seedling	Average	125.8824	8.0656	5.18	2.35	2.88	
			Stdev.	33.7988	2.5005	1.51	0.70	0.81	
	A(3x)	RRIM 600	Average	141.2500	11.6778	4.90	2.75	2.26	
			Stdev.	42.6699	2.7959	1.17	0.64	0.73	
	A(3x)	BPM 1	Average	161.0417	13.0313	5.57	2.78	2.78	
			Stdev.	37.8251	3.3432	0.79	0.42	0.80	
	A(6x)	Seedling	Average	101.1429	7.4577	5.63	2.47	3.33	
			Stdev.	51.8221	3.3380	1.61	0.84	1.03	
	A(6x)	RRIM 600	Average	164.2917	12.3438	5.21	2.79	2.42	
			Stdev.	63.2156	3.5467	1.14	0.93	0.83	
	A(6x)	BPM 1	Average	127.0000	13.7393	4.43	2.62	2.00	
			Stdev.	67.5020	5.2376	1.43	1.02	0.73	

M Lutan 22/2/97	A(3x)	Seedling	Average	32.7931	4.9050	1.42	1.42		
			Stdev.	39.9968	2.7175	0.86	0.86		
	A(3x)	RRIM 600	Average	79.8947	8.9368	2.89	2.89		
			Stdev.	42.6861	3.5270	0.81	0.81		
	A(3x)	RRIC 100	Average	36.0000	6.1333	1.62	1.52	1.00	
			Stdev.	13.2665	1.4338	0.50	0.51	0.00	
	A(3x)	PB 260	Average	87.1034	11.5086	2.64	2.39	1.00	
			Stdev.	30.0872	3.1315	0.49	0.63	0.00	
	A(3x)	BPM 1	Average	54.5000	7.6768	2.17	2.10	1.00	
			Stdev.	14.2893	1.3607	0.60	0.62		
	B(6x)	Seedling	Average	12.8462	3.6333	1.20	1.20		
			Stdev.	11.2878	0.7228	0.41	0.41		
	B(6x)	RRIM 600	Average	65.8148	7.8667	2.24	2.00	1.00	
			Stdev.	36.6585	3.0837	1.01	0.91	0.00	
	B(6x)	RRIC 100	Average	49.3571	22.6536	1.85	1.85		
			Stdev.	27.0288	53.2991	0.69	0.69		
	B(6x)	PB 260	Average	93.1724	10.6414	2.72	2.72		
			Stdev.	27.4592	2.8900	0.45	0.45		
	B(6x)	BPM 1	Average	68.1250	8.8938	2.46	2.42	1.00	
			Stdev.	30.1003	3.5254	0.83	0.78		
M Lutan 23/5/97	A(3x)	Seedling	Average	110.8667	11.7517	5.33	2.37	3.07	
			Stdev.	31.4486	4.5073	1.65	0.93	1.75	
	A(3x)	RRIM 600	Average	187.4737	22.6789	4.42	3.16	1.71	
			Stdev.	77.8520	16.6568	1.12	0.60	0.91	
	A(3x)	RRIC 100	Average	97.7917	12.1604	2.96	2.46	1.20	
			Stdev.	46.2366	3.9673	0.69	0.51	0.42	
	A(3x)	PB 260	Average	188.2759	27.7259	3.97	2.66	1.41	
			Stdev.	50.6584	9.4391	0.73	0.61	0.50	
	A(3x)	BPM 1	Average	110.9000	13.3100	3.53	3.23	1.13	
			Stdev.	30.3501	2.8580	0.94	0.82	0.35	
	B(6x)	Seedling	Average	111.7727	11.4000	5.59	2.67	3.05	
			Stdev.	30.9084	2.7725	1.44	0.73	1.65	
	B(6x)	RRIM 600	Average	139.2000	14.1300	4.27	2.67	1.71	
			Stdev.	91.3264	6.3866	1.51	0.84	0.85	
	B(6x)	RRIC 100	Average	84.7826	12.7087	2.61	2.13	1.38	
			Stdev.	60.1422	9.4396	1.27	0.81	0.74	
	B(6x)	PB 260	Average	187.0000	23.8483	4.24	3.07	1.28	
			Stdev.	54.1868	8.8891	0.58	0.54	0.65	
	B(6x)	BPM 1	Average	126.7333	14.7017	3.77	2.97	1.14	
			Stdev.	72.1703	8.0353	1.94	1.43	0.36	
M Lutan 20/8/97	A(3x)	Seedling	Average	150.7667	12.8450	6.34	2.71	3.72	
			Stdev.	47.2708	4.3587	1.45	0.85	1.31	
	A(3x)	RRIM 600	Average	218.0000	20.6063	5.58	3.42	2.60	
			Stdev.	118.0258	9.6446	2.36	1.35	0.68	
	A(3x)	RRIC 100	Average	159.0667	17.1183	4.07	2.43	1.63	
			Stdev.	221.8396	4.1404	0.94	0.68	0.56	
	A(3x)	PB 260	Average	250.1667	29.0150	5.72	3.14	2.59	
			Stdev.	72.3440	7.1082	1.03	0.58	0.78	
	A(3x)	BPM 1	Average	178.4000	69.5414	5.48	3.41	2.14	
			Stdev.	43.7852	249.4876	1.15	0.78	0.65	
	B(6x)	Seedling	Average	161.1667	13.7667	6.23	2.67	3.69	
			Stdev.	47.2492	5.0087	1.55	0.55	1.00	
	B(6x)	RRIM 600	Average	213.0333	22.6133	5.37	3.13	2.56	
			Stdev.	114.5463	8.9027	2.34	1.20	1.04	
	B(6x)	RRIC 100	Average	121.7500	16.0196	3.43	2.04	1.77	
			Stdev.	73.9107	8.3653	1.40	0.64	0.81	
	B(6x)	PB 260	Average	276.9667	30.1233	6.00	3.10	2.90	
			Stdev.	65.1568	5.6819	0.79	0.66	0.48	
	B(6x)	BPM 1	Average	198.2333	23.1833	5.40	3.55	2.27	
			Stdev.	106.4547	11.4594	2.59	1.66	0.83	
M Lutan 20/8/97i	A(3x)	Seedling	Average	150.7667	9.7981	6.34	2.71	3.72	
			Stdev.	47.2708	3.4666	1.45	0.85	1.31	
	A(3x)	RRIM 600	Average	218.0000	16.3524	5.58	3.42	2.60	
			Stdev.	118.0258	6.6141	2.36	1.35	0.68	
	A(3x)	RRIC 100	Average	218.0000	16.3524	5.58	3.42	2.60	
			Stdev.	118.0258	6.6141	2.36	1.35	0.68	
	A(3x)	PB 260	Average	250.1667	20.6768	5.72	3.14	2.59	
			Stdev.	72.3440	4.3919	1.03	0.58	0.78	
	A(3x)	BPM 1	Average	178.4000	16.8071	5.48	3.41	2.14	
			Stdev.	43.7852	4.4007	1.15	0.78	0.65	
	B(6x)	Seedling	Average	161.1667	9.9600	6.23	2.67	3.69	
			Stdev.	47.2492	3.5517	1.55	0.55	1.00	
	B(6x)	RRIM 600	Average	213.0333	18.6360	5.37	3.13	2.56	
			Stdev.	114.5463	5.7066	2.34	1.20	1.04	
	B(6x)	RRIC 100	Average	121.7500	15.7688	3.43	2.04	1.77	
			Stdev.	73.9107	4.6938	1.40	0.64	0.81	
	B(6x)	PB 260	Average	276.9667	21.0033	6.00	3.10	2.90	
			Stdev.	65.1568	4.3719	0.79	0.66	0.48	
	B(6x)	BPM 1	Average	198.2333	21.6773	5.40	3.55	2.27	
			Stdev.	106.4547	4.9664	2.59	1.66	0.83	

A Roni 20/2/97	A(3x)	Seedling	Average	5.1053	3.4639	1.33	1.33		
			Stdev	2.6645	1.7626	0.49	0.49		
	A(3x)	RRIM 600	Average	103.2593	12.3519	2.81	2.81		
			Stdev	29.2701	2.5723	0.48	0.48		
	A(3x)	RRIC 100	Average	96.3333	10.6900	2.17	2.17		
			Stdev	149.9718	1.7415	0.38	0.38		
	A(3x)	PB 260	Average	72.5000	23.2067	2.07	2.03	1.00	
			Stdev	31.6726	72.2282	0.58	0.61		
	A(3x)	BPM 1	Average	88.0000	11.9933	2.47	2.47		
			Stdev	18.6603	1.8801	0.51	0.51		
	A(3x)	Seedling	Average	17.2500	4.0462	1.80	1.07	2.86	
			Stdev	13.6416	1.5621	1.82	0.26	2.12	
	A(3x)	RRIM 600	Average	118.9655	15.6293	3.00	2.93	1.00	
			Stdev	29.8023	13.4083	0.53	0.53	0.00	
	A(3x)	RRIC 100	Average	81.7407	13.3926	2.37	2.37		
			Stdev	16.3721	9.0852	0.49	0.49		
	B(6x)	PB 260	Average	97.9286	10.6446	2.46	2.39	1.00	
			Stdev	31.4041	2.1233	0.51	0.57	0.00	
	A(3x)	BPM 1	Average	85.7333	11.0167	2.87	2.70	1.25	
			Stdev	26.3909	2.6129	0.51	0.53	0.50	
A Roni 21/5/97	A(3x)	Seedling	Average	107.1034	9.3690	5.17	2.17	3.35	
			Stdev	35.3476	3.2761	2.00	0.97	1.67	
	A(3x)	RRIM 600	Average	266.4333	23.5850	5.57	3.87	1.70	
			Stdev	71.9256	5.6083	0.90	0.68	0.75	
	A(3x)	RRIC 100	Average	163.7333	21.4100	4.57	3.17	1.40	
			Stdev	21.3104	2.8989	0.63	0.53	0.56	
	A(3x)	PB 260	Average	167.1333	19.1817	4.20	3.07	1.26	
			Stdev	84.7771	7.3135	1.06	0.91	0.45	
	A(3x)	BPM 1	Average	198.0000	22.3783	5.17	4.03	1.13	
			Stdev	24.1960	2.7217	0.59	0.49	0.35	
	A(3x)	Seedling	Average	87.2857	7.8804	4.69	2.40	2.95	
			Stdev	33.4906	2.4308	2.20	1.22	2.52	
	A(3x)	RRIM 600	Average	286.3000	66.2600	5.67	4.10	1.62	
			Stdev	69.4476	226.9419	1.03	0.92	0.49	
	A(3x)	RRIC 100	Average	174.4000	22.1233	4.90	3.47	1.43	
			Stdev	31.6180	4.0365	0.55	0.78	0.50	
	B(6x)	PB 260	Average	223.2333	22.3533	4.93	3.48	1.47	
			Stdev	47.4165	4.1136	0.53	0.63	0.51	
	A(3x)	BPM 1	Average	196.2000	23.3583	5.23	4.00	1.28	
			Stdev	43.9321	4.6704	0.73	0.64	0.45	
A Roni 20/8/97	A(3x)	Seedling	Average	179.6333	17.8350	5.53	2.43	3.44	
			Stdev	61.1868	7.9741	1.87	0.73	0.93	
	A(3x)	RRIM 600	Average	419.6000	33.2050	7.87	4.50	3.37	
			Stdev	95.3851	5.4668	1.20	0.73	0.89	
	A(3x)	RRIC 100	Average	250.0000	33.8633	6.57	3.43	3.10	
			Stdev	32.3760	3.4419	0.77	0.73	0.40	
	A(3x)	PB 260	Average	289.0000	29.2083	6.03	3.13	2.90	
			Stdev	107.4132	9.2352	1.30	0.90	0.55	
	A(3x)	BPM 1	Average	330.2667	34.4917	7.97	5.40	2.53	
			Stdev	41.5285	3.3334	0.89	0.77	0.63	
	A(3x)	Seedling	Average	156.9000	14.2783	7.33	3.37	4.24	
			Stdev	66.1760	6.7063	2.43	1.07	2.13	
	A(3x)	RRIM 600	Average	435.2667	34.4583	8.47	5.03	3.59	
			Stdev	85.7912	5.5686	1.20	0.76	0.50	
	A(3x)	RRIC 100	Average	250.3133	33.8717	7.83	4.83	3.00	
			Stdev	60.7608	5.5523	0.99	1.18	0.59	
	B(6x)	PB 260	Average	345.1000	34.1717	7.37	4.20	3.17	
			Stdev	76.8861	5.9298	0.89	1.00	0.46	
	A(3x)	BPM 1	Average	325.1667	34.5383	8.50	5.70	2.80	
			Stdev	59.3459	4.9512	1.01	0.79	0.66	
A Roni 20/8/97i	A(3x)	Seedling	Average	179.6333	12.9577	5.53	2.43	3.44	
			Stdev	61.1868	3.6232	1.87	0.73	0.93	
	A(3x)	RRIM 600	Average	419.6000	26.3448	7.87	4.50	3.37	
			Stdev	95.3851	3.7043	1.20	0.73	0.89	
	A(3x)	RRIC 100	Average	250.0000	25.3700	6.57	3.43	3.10	
			Stdev	32.3760	2.8881	0.77	0.73	0.40	
	A(3x)	PB 260	Average	289.0000	20.7267	6.03	3.13	2.90	
			Stdev	107.4132	6.7721	1.30	0.90	0.55	
	A(3x)	BPM 1	Average	330.2667	26.9183	7.97	5.40	2.53	
			Stdev	41.5285	2.6608	0.89	0.77	0.63	
	A(3x)	Seedling	Average	156.9000	10.6017	7.33	3.37	4.24	
			Stdev	66.1760	4.0253	2.43	1.07	2.13	
	A(3x)	RRIM 600	Average	435.2667	26.9933	8.47	5.03	3.59	
			Stdev	85.7912	4.0450	1.20	0.76	0.50	
	A(3x)	RRIC 100	Average	250.3133	30.5967	7.83	4.83	3.00	
			Stdev	60.7608	27.4455	0.99	1.18	0.59	
	B(6x)	PB 260	Average	345.1000	26.4552	7.37	4.20	3.17	
			Stdev	76.8861	2.1900	0.89	1.00	0.46	
	A(3x)	BPM 1	Average	325.1667	27.3017	8.50	5.70	2.80	
			Stdev	59.3459	4.2926	1.01	0.79	0.66	

Taridi 22/2/97	A(3x)	Seedling	Average	25.2308	3.7614	1.16	1.16		
			Stdev	17.3027	1.4168	0.37	0.37		
	A(3x)	RRIM 600	Average	95.8667	11.6967	2.80	2.57	1.00	
			Stdev	30.5679	2.4916	0.48	0.57	0.00	
	A(3x)	RRIC 100	Average	83.3333	11.8200	2.90	2.77	1.00	
			Stdev	29.2791	2.9480	0.31	0.43	0.00	
	A(3x)	PB 260	Average	122.9333	14.2200	3.10	2.80	1.00	
			Stdev	28.6945	2.4186	0.31	0.41	0.00	
	A(3x)	BPM 1	Average	145.0667	16.4017	3.27	3.07	1.00	
			Stdev	19.5870	2.4768	0.52	0.45	0.00	
	B(6x)	Seedling	Average	15.4000	3.4810	1.34	1.34		
			Stdev	10.8074	1.0325	0.48	0.48		
	B(6x)	RRIM 600	Average	92.3333	11.7417	2.97	2.57	1.00	
			Stdev	26.8859	2.5865	0.49	0.50	0.00	
	B(6x)	RRIC 100	Average	89.8000	12.4117	3.07	2.60	1.08	
			Stdev	20.8846	2.5711	0.45	0.50	0.28	
	B(6x)	PB 260	Average	133.4667	14.9300	3.07	2.40	1.18	
			Stdev	28.3436	3.0180	0.45	0.50	0.53	
	B(6x)	BPM 1	Average	138.3000	15.2117	3.37	3.00	1.00	
			Stdev	25.1453	2.1592	0.56	0.37	0.00	
Taridi 23/5/97	A(3x)	Seedling	Average	129.8333	11.5100	5.60	2.62	3.54	
			Stdev	34.8020	3.2382	1.81	0.98	1.65	
	A(3x)	RRIM 600	Average	194.1667	21.8917	5.00	3.33	1.67	
			Stdev	60.6744	5.1003	0.83	0.71	0.66	
	A(3x)	RRIC 100	Average	184.6000	21.8700	5.07	3.33	1.73	
			Stdev	46.6939	4.7156	0.58	0.55	0.45	
	A(3x)	PB 260	Average	267.8667	25.2817	5.30	3.43	1.87	
			Stdev	43.0947	5.3509	0.65	0.63	0.63	
	A(3x)	BPM 1	Average	267.3667	29.4217	6.03	4.80	1.23	
			Stdev	39.1694	2.7078	0.49	0.61	0.43	
	B(6x)	Seedling	Average	128.5000	13.6150	4.73	2.80	2.00	
			Stdev	37.6332	5.7738	1.23	0.61	1.28	
	B(6x)	RRIM 600	Average	199.4333	29.6200	5.50	3.10	2.40	
			Stdev	50.6568	7.7985	0.82	0.55	0.56	
	B(6x)	RRIC 100	Average	197.1000	32.0467	5.33	3.23	2.10	
			Stdev	32.7049	6.3701	1.06	0.63	0.61	
	B(6x)	PB 260	Average	289.8667	34.6117	5.77	3.67	2.10	
			Stdev	51.9202	5.4720	0.63	0.48	0.48	
	B(6x)	BPM 1	Average	264.7000	28.2567	6.03	4.80	1.23	
			Stdev	32.5239	3.2675	0.67	0.66	0.43	
Taridi 19/8/97	A(3x)	Seedling	Average	211.6333	17.9233	6.30	2.73	3.69	
			Stdev	56.7660	5.6584	1.37	0.74	0.76	
	A(3x)	RRIM 600	Average	282.6000	31.6933	6.43	3.50	2.93	
			Stdev	76.5329	4.9819	0.94	0.73	0.52	
	A(3x)	RRIC 100	Average	282.9667	33.0750	6.67	3.47	3.20	
			Stdev	65.8952	4.8856	1.03	0.68	0.66	
	A(3x)	PB 260	Average	396.3000	40.4333	7.13	3.50	3.63	
			Stdev	60.8691	30.1576	0.86	0.63	0.56	
	A(3x)	BPM 1	Average	399.4667	37.9217	8.57	5.67	2.90	
			Stdev	49.5996	3.0555	1.04	1.03	0.61	
	B(6x)	Seedling	Average	219.5000	20.4067	8.47	2.93	5.33	
			Stdev	58.6484	5.6966	1.38	0.87	1.47	
	B(6x)	RRIM 600	Average	288.1667	34.7300	8.70	4.17	4.50	
			Stdev	65.6160	4.0312	1.12	0.83	0.78	
	B(6x)	RRIC 100	Average	287.5333	35.6300	8.60	4.23	4.50	
			Stdev	52.7020	5.1882	1.25	0.82	0.68	
	B(6x)	PB 260	Average	404.7333	36.8450	8.80	4.20	4.60	
			Stdev	67.3529	4.1036	1.10	0.71	0.77	
	B(6x)	BPM 1	Average	390.9000	37.8617	9.03	5.80	3.27	
			Stdev	52.5996	4.9560	1.03	1.06	0.52	
Taridi 19/8/97i	A(3x)	Seedling	Average	211.6333	13.4983	6.30	2.73	3.69	
			Stdev	56.7660	4.1464	1.37	0.74	0.76	
	A(3x)	RRIM 600	Average	282.6000	24.1200	6.43	3.50	2.93	
			Stdev	76.5329	4.9966	0.94	0.73	0.52	
	A(3x)	RRIC 100	Average	282.9667	25.1350	6.67	3.47	3.20	
			Stdev	65.8952	4.3660	1.03	0.68	0.66	
	A(3x)	PB 260	Average	396.3000	25.8633	7.13	3.50	3.63	
			Stdev	60.8691	3.6056	0.86	0.63	0.56	
	A(3x)	BPM 1	Average	399.4667	29.6567	8.57	5.67	2.90	
			Stdev	49.5996	2.3823	1.04	1.03	0.61	
	B(6x)	Seedling	Average	219.5000	19.6650	8.47	2.93	5.33	
			Stdev	58.6484	27.6017	1.38	0.87	1.47	
	B(6x)	RRIM 600	Average	288.1667	26.3617	8.70	4.17	4.50	
			Stdev	65.6160	3.6446	1.12	0.83	0.78	
	B(6x)	RRIC 100	Average	287.5333	26.9467	8.60	4.23	4.50	
			Stdev	52.7020	3.5917	1.25	0.82	0.68	
	B(6x)	PB 260	Average	404.7333	27.7767	8.80	4.20	4.60	
			Stdev	67.3529	4.3940	1.10	0.71	0.77	
	B(6x)	BPM 1	Average	390.9000	29.7517	9.03	5.80	3.27	
			Stdev	52.5996	3.7310	1.03	1.06	0.52	

Yusuf 26/2/97	A(3x)	Seedling	Average	18.8571	7.1750	1.76	1.71	1.00	
			Stdev	11.3898	2.5828	0.44	0.46		
	A(3x)	PB 260	Average	89.6667	10.7000	2.24	2.19	1.00	
			Stdev	31.1438	2.3224	0.62	0.60		
	A(3x)	RRIC 100	Average	97.5000	13.5568	2.55	2.50	1.00	
			Stdev	25.2318	1.7869	0.51	0.51		
	B(6x)	Seedling	Average	18.6842	5.8722	1.59	1.59		
			Stdev	22.8329	1.4131	0.71	0.71		
	B(6x)	PB 260	Average	131.9091	16.7205	3.00	2.50	1.10	
			Stdev	18.4595	2.1239	0.00	0.60	0.32	
	B(6x)	RRIC 100	Average	119.3333	20.1429	3.00	2.48	1.00	
			Stdev	16.3228	11.3709	0.00	0.51	0.00	
Yusuf 22/5/97	A(3x)	Seedling	Average	201.6818	17.6205	7.18	3.14	4.24	
			Stdev	51.6558	4.8309	2.04	0.89	1.41	
	A(3x)	PB 260	Average	174.2273	18.3250	4.10	2.76	1.47	
			Stdev	72.2574	4.6473	1.22	0.83	0.70	
	A(3x)	RRIC 100	Average	200.0000	24.1977	4.09	3.00	1.14	
			Stdev	29.7065	3.4101	0.53	0.31	0.36	
	B(6x)	Seedling	Average	134.6190	14.6500	4.63	2.32	2.44	
			Stdev	41.4457	4.6912	1.12	0.75	0.92	
	B(6x)	PB 260	Average	263.0455	27.0545	4.77	3.05	1.73	
			Stdev	45.5270	2.2620	0.69	0.58	0.46	
	B(6x)	RRIC 100	Average	213.0455	29.2591	4.82	3.09	1.73	
			Stdev	46.8030	6.2787	0.66	0.53	0.46	
Yusuf 22/8/97	A(3x)	Seedling	Average	293.0909	30.1023	9.27	3.09	6.18	
			Stdev	63.4432	8.7918	2.14	0.61	2.02	
	A(3x)	PB 260	Average	262.7727	28.9250	5.41	2.50	3.00	
			Stdev	67.4826	6.2019	0.96	0.51	0.45	
	A(3x)	RRIC 100	Average	270.9091	27.6068	6.55	3.41	3.14	
			Stdev	29.0958	2.8464	0.80	0.73	0.35	
	B(6x)	Seedling	Average	194.4545	21.1523	7.00	2.32	4.68	
			Stdev	60.9916	7.8776	1.80	0.78	1.67	
	B(6x)	PB 260	Average	347.0909	39.2614	6.59	3.41	3.18	
			Stdev	49.8683	3.1047	0.80	0.50	0.66	
	B(6x)	RRIC 100	Average	296.9545	41.1841	6.95	3.91	3.05	
			Stdev	37.9216	4.8955	0.84	0.81	0.49	
Yusuf 22/8/97i	A(3x)	Seedling	Average	293.0909	21.7975	9.27	3.09	6.18	
			Stdev	63.4432	4.1134	2.14	0.61	2.02	
	A(3x)	PB 260	Average	262.7727	21.5568	5.41	2.50	2.86	
			Stdev	67.4826	4.5262	0.96	0.51	0.77	
	A(3x)	RRIC 100	Average	270.9091	27.6068	6.55	3.41	3.14	
			Stdev	29.0958	2.8464	0.80	0.73	0.35	
	B(6x)	Seedling	Average	194.4545	13.9136	7.00	2.32	4.68	
			Stdev	60.9916	5.4694	1.80	0.78	1.67	
	B(6x)	PB 260	Average	347.0909	29.4045	6.59	3.41	3.18	
			Stdev	49.8683	3.3269	0.80	0.50	0.66	
	B(6x)	RRIC 100	Average	296.9545	31.1795	6.95	3.91	3.05	
			Stdev	37.9216	4.4926	0.84	0.81	0.49	



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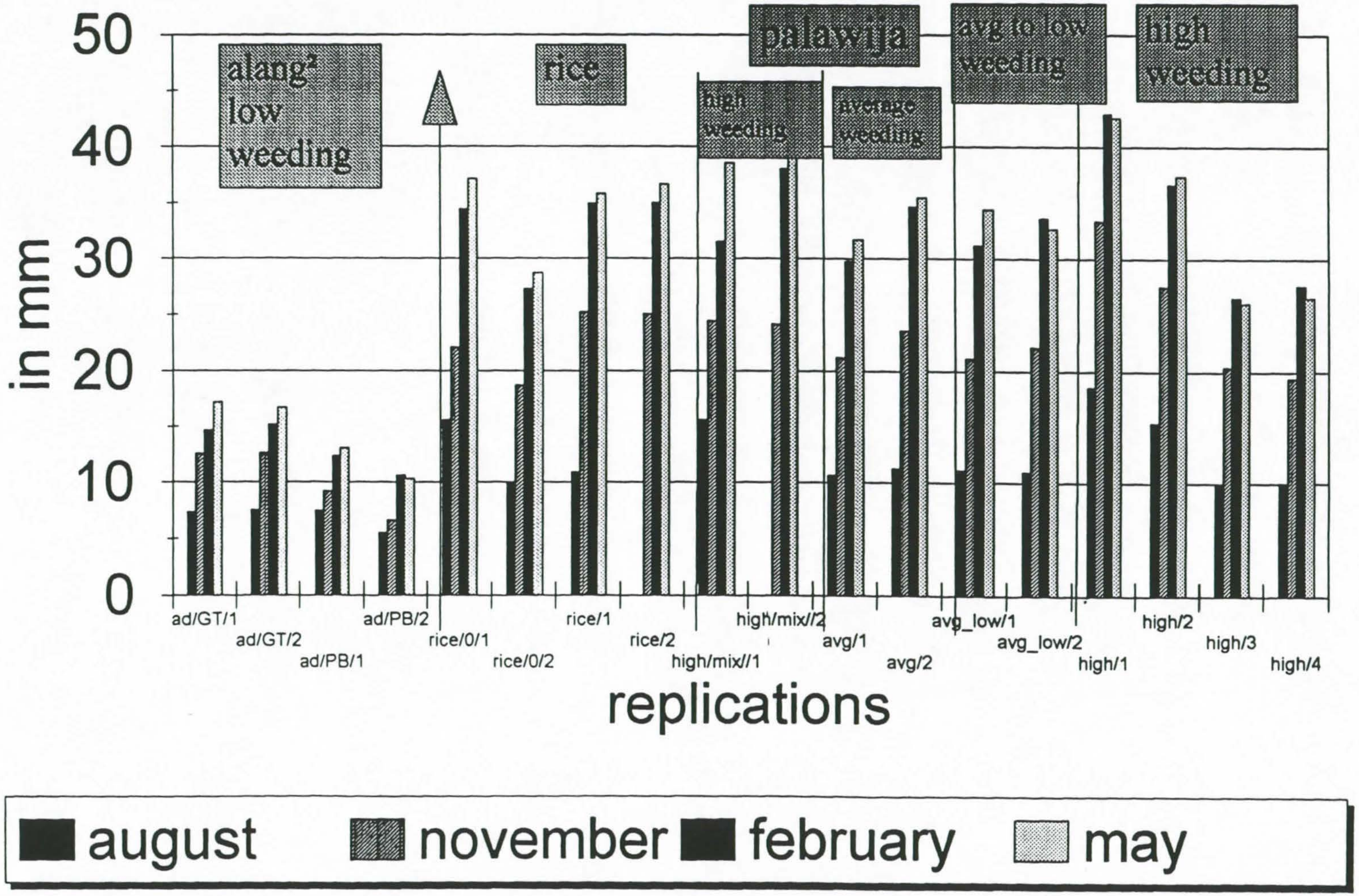
*Sheet5 C hart 1

RAS 2

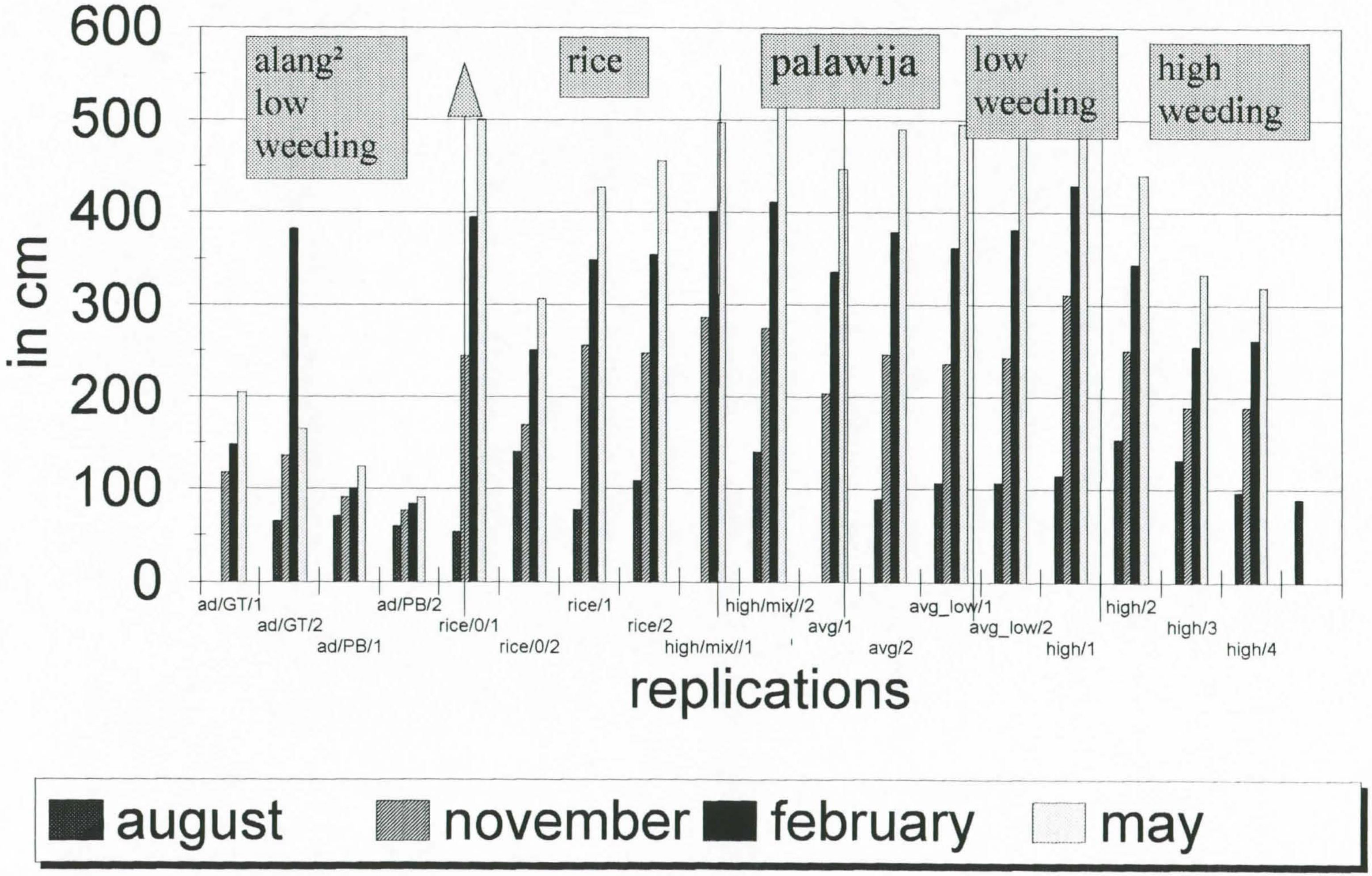
RAS 2.2 in Jambi province

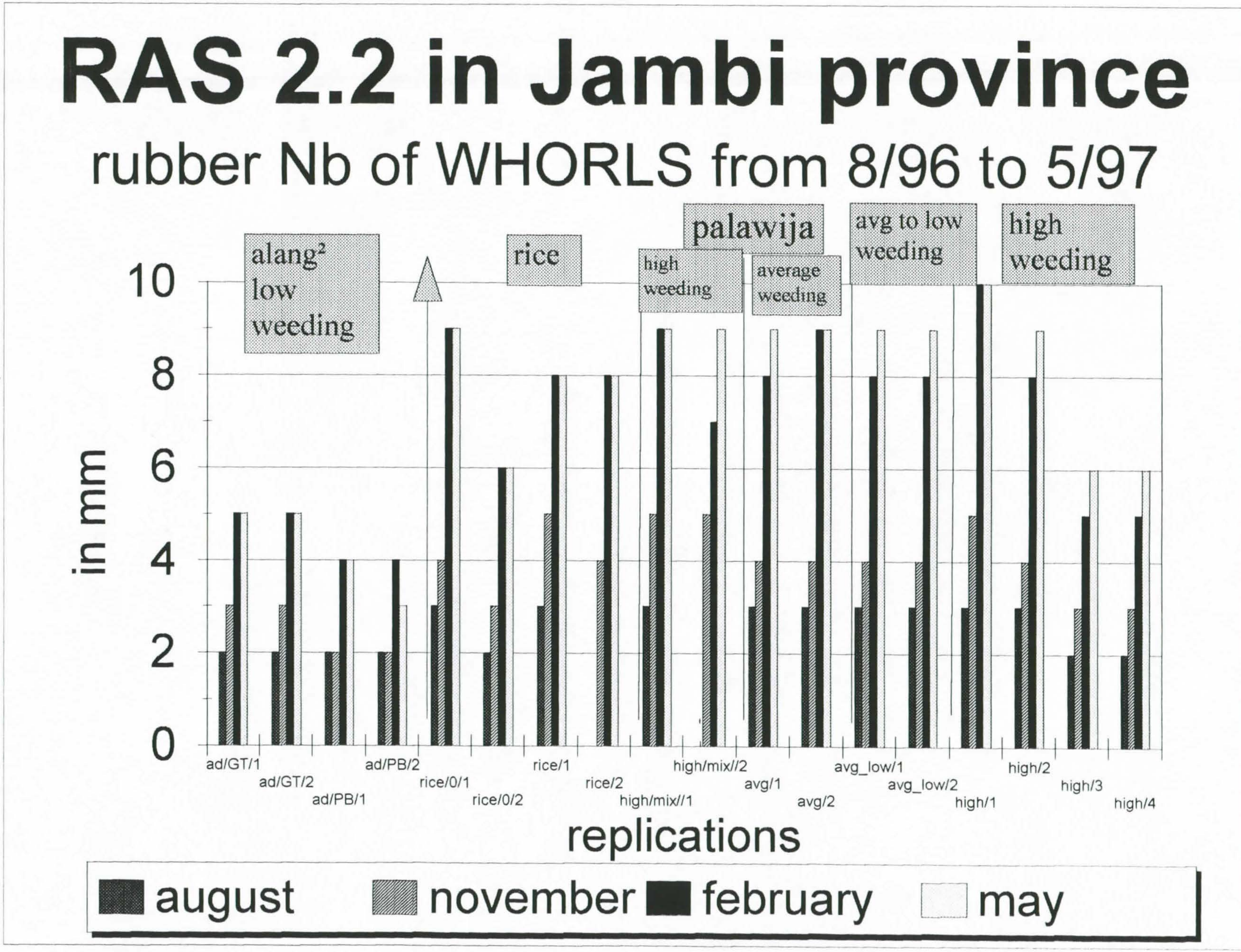
rubber DIAMETER from 8/96 to 5/97



RAS 2.2 in Jambi province

rubber HEIGHT from 8/96 to 5/97




RAS 2.2 in Jambi province
rubber Nb of WHORLS from 8/96 to 5/97
alang² low weeding
rice
palawija
high weeding
average weeding
avg to low weeding
high weeding
10
8
6
4
2
0
in mm
ad/GT/1
ad/GT/2
ad/PB/1
ad/PB/2
rice/0/1
rice/0/2
rice/1
rice/2
high/mix//1
high/mix//2
avg/1
avg/2
avg_low/1
avg_low/2
high/1
high/2
high/3
high/4
replications
august
november
february
may

Soils and rainfall data for Jambi

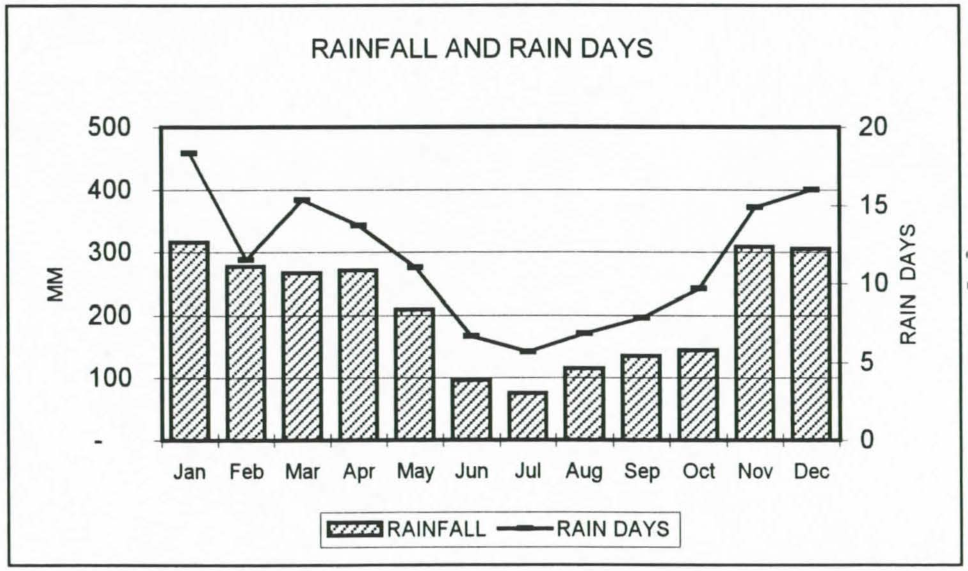
RAINFALL AND WATER DEFICIT

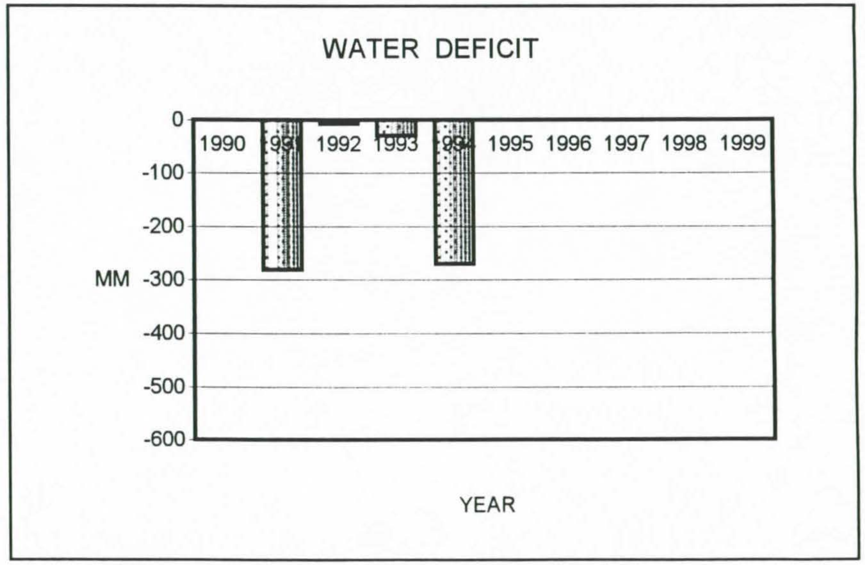
MUARA BUNGO

Month	1990		1991		1992		1993		1994		1995		1996		1997		1998		1999		Average	
	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD	MM	RD
January	299	13	230	13	223	15	258	19	479	26	404	24									316	18
February	378	14	131	8	161	9	237	11	279	10	477	17									277	12
March	24	13	258	16	183	12	273	16	499	20	362	15									267	15
April	206	11	277	15	157	10	295	15	351	12	341	19									271	14
May	175	8	123	11	145	8	244	16	128	11	440	12									209	11
June	104	7	27	3	105	6	89	7	193	6	61	11									97	7
July	140	10	20	3	112	5	97	7	22	1	59	8									75	6
August	141	7	90	5	139	8	112	6	38	5	169	10									115	7
September	226	11	151	6	92	7	123	8	43	4	172	11									135	8
October	155	11	30	3	216	11	240	12	76	5	148	16									144	10
November	367	14	269	15	302	18	285	15	292	15	336	12									309	15
December	356	17	252	15	250	18	301	14	354	14	320	18									306	16
Total	2571	136	1858	113	2085	127	2554	146	2754	129	3289	173	-	-	-	-	-	-	-	-	2519	137
Water Deficit	0 mm		-282 mm		-7 mm		-29 mm		-271 mm		0 mm		- mm		- mm		- mm		- mm		-98 mm	

Soil Water Reserves : 150 mm

Period of water deficit: light deficit / severe deficit





DATA SOIL ANALISIS RAS
HASIL ANALISIS CONTOH TANAH RAS

RAS	Farmer Petani	Plot	Depth soil Batas horison	Texture Sand Pasir	Silt Debu	Clay Liat	Extract 1 : 2.5 pH H2O	pH KCl	Organic matter C	N	C/N	HCl 25 % P2O5	K2O	Terhadap contoh kering 105 C Cathions content (NH4-Acetat 1N.pH7) Ca	Mg	K	Na	total	KTK	KB+	KCl 1N Al3+	H+
				---- % ----					---- % ----			---- mg/100 g		---------- me/100 g ----------						%	---- mg/100 g ----	
1	Azahri	A	0-5 cm	36	43	21	3.9	3.6	3.33	0.24	14	21	8	0.67	0.29	0.1	0	1.06	11.97	9	4.14	
			5-20 cm	35	42	23	3.8	3.6	2.51	0.2	13	18	6	0.41	0.2	0.08	0	0.69	9.16	8	4.55	
1	Azahri	B	0-5 cm	36	43	21	4.1	3.8	2.18	0.2	11	14	7	0.42	0.43	0.08	0.06	0.99	8.19	12	3.39	
			5-20 cm	8	86	6	3.9	3.6	3.33	0.26	13	19	10	0.62	0.46	0.16	0	1.24	10.86	11	4.61	
1	Azahri	C	0-5 cm	42	41	17	4.1	3.8	1.84	0.15	12	15	5	0.36	0.3	0.08	0	0.74	6.25	12	2.65	
			5-20 cm	30	44	26	4.1	3.8	1.14	0.11	10	13	4	0.25	0.28	0.08	0	0.61	5.2	12	2.44	
1	Azahri	D	0-5 cm	33	45	22	4.1	3.7	3.06	0.22	14	18	8	0.36	0.34	0.14	0.02	0.86	9.78	9	3.02	
			5-20 cm	10	85	5	4	3.6	3.1	0.23	13	18	8	0.26	0.41	0.12	0	0.79	9.37	8	4.01	
1	Bustami	A	0-5 cm	36	20	44	3.9	3.5	3.05	0.23	13	22	12	0.57	0.27	0.16	0.02	1.02	13.71	7	6.64	
			5-20 cm	34	17	49	4.1	3.6	2.52	0.22	11	19	10	0.26	0.24	0.1	0.02	0.62	11.58	5	6.72	
1	Bustami	B	0-5 cm	31	21	48	3.9	3.5	3.83	0.3	13	29	19	0.94	0.46	0.25	0.03	1.68	14.96	11	8.58	
			5-20 cm	39	19	42	3.9	3.5	2.12	0.2	11	20	14	0.42	0.32	0.16	0.02	0.92	11.32	8	7.86	
1	Bustami	C	0-5 cm	42	18	40	3.9	3.6	3.43	0.25	14	22	13	0.78	0.2	0.16	0.02	1.16	11.14	10	5.55	
			5-20 cm	38	19	43	3.9	3.7	2.19	0.17	13	21	10	0.57	0.12	0.08	0	0.77	10.58	7	5.76	
1	Bustami	D	0-5 cm	40	18	42	4.1	3.7	3.4	0.26	13	24	12	1.35	0.34	0.16	0	1.85	10.58	17	4.23	
			5-20 cm	38	17	45	4.1	3.7	2.18	0.2	11	21	10	0.67	0.22	0.08	0	0.97	9.03	11	4.65	
1	Ismail	A	0-5 cm	21	37	42	4.1	3.8	3.27	0.26	13	17	24	4.82	1.14	0.39	0.06	6.41	15.04	43	2.76	
			5-20 cm	19	36	45	3.8	3.5	1.66	0.14	12	13	15	2.11	0.64	0.17	0.06	2.98	13.66	22	6.97	
1	Ismail	B	0-5 cm	11	46	43	4.6	3.7	3	0.19	17	17	23	2.39	0.86	0.33	0.06	3.64	14.44	25	3.95	
			5-20 cm	9	42	49	3.9	3.6	1.34	0.13	10	13	33	0.8	0.39	0.11	0.06	1.36	11.62	12	7.26	
1	Ismail	C	0-5 cm	37	31	32	4.5	3.8	2.25	0.18	13	15	30	2.43	0.66	0.49	0.05	3.63	8.08	45	1.65	
			5-20 cm	23	38	39	4	3.7	1.82	0.14	13	14	14	1.8	0.49	0.18	0.02	2.49	10.17	24	3.38	
1	Ismail	D	0-5 cm	44	30	26	4.5	4.1	2.18	0.15	15	15	14	3.9	0.88	0.2	0.02	5	9.56	52	1.11	
			5-20 cm	35	33	32	4.4	3.9	2.08	0.15	14	14	14	3.36	0.71	0.18	0	4.25	7.04	60	1.9	
1	Saryono	A	0-5 cm	50	10	40	4.2	4	3.45	0.23	15	24	12	1.18	0.59	0.16	0.02	1.95	7.7	25	1.69	
			5-20 cm	47	11	42	4	3.8	2.32	0.13	18	14	8	0.41	0.51	0.1	0.02	1.04	6.44	16	2.04	
1	Saryono	B	0-5 cm	51	17	32	4	3.8	2.97	0.23	13	19	41	1.6	0.46	0.33	0.05	2.44	11.02	22	2.1	
			5-20 cm	48	13	39	4.5	4.1	2.92	0.24	12	22	25	1.8	0.66	0.41	0.02	2.89	8.41	34	0.93	
1	Saryono	C	0-5 cm	52	10	38	4	3.9	2.37	0.18	13	18	13	0.61	0.27	0.16	0	1.04	6.97	15	1.84	
			5-20 cm	46	12	42	3.9	3.8	2.21	0.16	14	18	10	0.67	0.29	0.12	0.18	1.26	6.43	20	2.16	
1	Saryono	D	0-5 cm	44	13	43	4.4	4	3.39	0.25	14	22	32	1.91	0.71	0.55	0.02	3.19	7.15	45	1.15	
			5-20 cm	44	13	43	4.3	3.9	3.14	0.22	14	21	25	1.18	0.57	0.43	0	2.18	7.48	29	1.32	
1.1	Aljupri	A	0-5 cm	7	9	84	4.1	3.9	3.12	0.22	14	71	12	1.17	0.62	0.2	0.08	2.07	12.93	16	2.81	
			5-20 cm	6	23	71	3.9	3.7	3.14	0.24	13	66	8	0.53	0.23	0.1	0.05	0.91	13.77	7	3.65	
1.1	Aljupri	B	0-5 cm	6	11	83	3.9	3.7	3.82	0.33	12	77	12	2.29	0.79	0.17	0.07	3.32	12.42	27	2.16	
			5-20 cm	6	9	85	3.9	3.6	2.83	0.25	11	69	9	0.89	0.47	0.14	0.01	1.51	13.44	11	2.94	
1.1	Aljupri	C	0-5 cm	6	23	71	3.9	3.7	2.9	0.23	13	62	8	0.93	0.49	0.12	0.01	1.55	10.72	14	2.99	
			5-20 cm	6	14	80	3.8	3.6	2.56	0.2	13	68	9	0.79	0.43	0.14	0.01	1.37	11.35	12	2.94	
1.1	Aljupri	D	0-5 cm	4	9	87	3.8	3.7	4.95	0.32	15	79	10	0.56	0.37	0.17	0.05	1.15	16.78	7	4.49	
			5-20 cm	7	7	86	3.8	3.7	2.94	0.2	15	67	8	0.42	0.33	0.1	0.06	0.91	11.28	8	3.21	
1.1	A. Roni	A	0-5 cm	13	12	75	3.8	3.7	2.94	0.23	13	23	7	0.57	0.24	0.12	0	0.93	9.93	9	2.08	
			5-20 cm	29	14	57	3.6	3.5	3.67	0.24	15	29	12	0.93	0.38	0.23	0.02	1.56	11.79	13	3.44	
1.1	A. Roni	B	0-5 cm	24	14	62	3.5	3.3	6.13	0.39	16	33	16	0.99	0.67	0.31	0.06	2.03	19.94	10	5.57	
			5-20 cm	25	11	64	3.8	3.7	3.24	0.23	14	24	14	1.09	0.67	0.27	0	2.03	11.3	18	4.11	
1.1	A. Roni	C	0-5 cm	30	13	57	4	3.5	3.17	0.22	14	28	12	2.07	0.59	0.22	0.02	2.9	9	32	1.9	
			5-20 cm	29	12	59	3.9	3.8	1.37	0.14	10	22	9	1.19	0.41	0.16	0	1.76	7.18	25	2.07	
1.1	A. Roni	D	0-5 cm	30	16	54	3.7	3.5	6.44	0.45	14	43	47	3.34	1.49	0.97	0	5.8	23.58	25	2.71	
		1	5-20 cm	30	13	57	3.8	3.7	3.97	0.25	16	26	16	0.68	0.46	0.33	0.02	1.49	14.94	10	3.41	
1.1	Azwar	A	0-5 cm	32	10	58	4.1	3.6	2.72	0.21	13	19	12	0.96	0.47	0.25	0	1.68	9.04	19	2.76	
			5-20 cm	29	10	61	3.9	3.6	2.25	0.17	13	19	7	0.48	0.3	0.13	0	0.91	10.13	9	2.6	
1.1	Azwar	B	0-5 cm	29	10	61	4.3	3.9	2.39	0.23	10	24	26	2.2	1.02	0.5	0	3.72	12.68	29	1.15	
			5-20 cm	7	14	79	3.9	3.7	4.05	0.31	13	29	8	0.86	0.33	0.16	0	1.35	14.3	9	2.79	
1.1	Azwar	C	0-5 cm	27	12	61	4.4	4	4.09	0.32	13	30	17	4.18	1.3	0.34	0.02	5.84	14.08	41	1.2	
			5-20 cm	23	11	66	4.2	3.7	1.55	0.17	9	20	14	1.61	0.74	0.28	0.06	2.69	8.53	32	1.93	
1.1	Azwar	D	0-5 cm	30	12	58	3.8	3.6	1.9	0.24	8	19	8	0.78	0.58	0.16	0.02	1.54	11.17	14	2.72	
			5-20 cm	32	10	58	4.1	3.7	1.52	0.16	10	19	7	1.21	0.47	0.12	0.02	1.82	7.22	25	1.47	
1.1	Eman	A	0-5 cm	9	15	76	3.7	3.6	3.64	0.34	11	58	9	0.93	0.46	0.16	0.04	1.49	12.33	12	3.57	
			5-20 cm	8	15	77	3.8	3.7	2.34	0.22	11	53	8	0.52	0.36	0.12	0.03	1.03	8.84	12	3.15	

RAS	Farmer		Depth soil		Texture		Extract 1 : 2.5							Terhadap contoh kering 105 C							
	Petani	Plot	Batas horison	Sand	Silt	Clay	pH		Organic matter			HCl 25 %		Cathions content (NH4-Acetat 1N.pH7)						KCl 1N	
				Pasir	Debu	Liat	H2O	KCl	C	N	C/N	P2O5	K2O	Ca	Mg	K	Na	total	KTK	KB+	Al3+	H+
					--- % ---					--- % ---		--- mg/100 g			--- me/100 g ---					%	--- mg/100 g ---	
1.1	Eman	B	0-5 cm	2	66	32	3.9	3.8	1.65	0.17	10	5	10	0.9	0.47	0.16	0.02	1.55	7.58	20	2.51	
			5-20 cm	6	12	82	3.8	3.7	1.75	0.17	10	47	8	0.68	0.29	0.13	0.02	1.12	12.76	9	2.49	
1.1	Eman	C	0-5 cm	6	13	81	4.2	4.2	3.79	0.33	11	49	15	3.58	1.42	0.29	0.02	5.32	14.21	37	0.53	
			5-20 cm	6	11	83	4.1	3.8	1.99	0.21	9	32	15	1.31	0.74	0.27	0	2.32	11.07	21	1.68	
1.1	Eman	D	0-5 cm	9	15	76	3.5	3.4	3.19	0.27	12	36	10	0.37	0.29	0.19	0	0.85	13.62	6	4.13	
			5-20 cm	7	12	81	4	3.7	2.23	0.21	11	31	17	1.68	0.64	0.31	0	2.63	11.82	22	1.85	
1.1	Sahroni	A	0-5 cm	5	13	82	4.1	3.7	3.55	0.27	13	68	14	1.22	0.67	0.25	0.08	2.22	12.13	18	2.39	
			5-20 cm	4	14	82	3.9	3.8	3.02	0.25	12	65	15	1.17	0.63	0.24	0.02	2.06	11.02	19	2.5	
1.1	Sahroni	B	0-5 cm	5	13	82	3.7	3.6	3.84	0.34	11	60	14	1.38	0.68	0.24	0.06	2.36	12.3	19	3.14	
			5-20 cm	5	11	84	3.9	3.7	2.94	0.27	11	62	12	1.41	0.67	0.2	0.04	2.32	11.63	20	2.14	
1.1	Sahroni	C	0-5 cm	5	14	81	4	3.9	4.28	0.3	14	63	13	2.99	1.19	0.24	0.03	4.45	12.48	36	1.26	
			5-20 cm	4	10	86	4.1	3.8	2.6	0.25	10	61	13	2.17	0.93	0.22	0.06	3.38	10.03	32	1.35	
1.1	Sahroni	D	0-5 cm	6	13	81	3.8	3.7	4.54	0.35	13	72	12	1.69	0.92	0.2	0.02	2.83	13.55	21	2.45	
			5-20 cm	5	12	83	4	3.8	3.44	0.29	12	75	11	1.75	0.89	0.19	0.02	2.85	12.46	23	2.33	
1.1	Zulkifli	A	0-5 cm	5	10	85	3.7	3.5	2.95	0.28	11	21	10	0.83	0.46	0.16	0.02	1.47	10.28	14	3.12	
			5-20 cm	5	11	84	3.8	3.6	3.01	0.22	14	20	9	1.25	0.57	0.17	0.02	2.01	12.55	16	2.79	
1.1	Zulkifli	B	0-5 cm	5	10	85	3.9	3.7	2.98	0.25	12	18	14	1.82	0.58	0.24	0	2.64	10.9	24	2.21	
			5-20 cm	5	11	84	4.1	3.8	3.92	0.3	13	24	16	2.29	1.17	0.27	0	3.73	12.64	30	2.06	
1.1	Zulkifli	C	0-5 cm	5	11	84	4.4	4	3.83	0.3	13	24	17	2.34	1.14	0.31	0.02	3.81	14.91	26	1.16	
			5-20 cm	5	10	85	4.2	3.9	2.46	0.17	14	21	12	1.45	0.77	0.23	0	2.45	10.72	23	1.41	
1.1	Zulkifli	D	0-5 cm	5	11	84	3.9	3.7	4.53	0.32	14	27	18	2.37	0.99	0.33	0.02	3.71	17.53	21	1.94	
			5-20 cm	4	8	88	3.8	3.7	3.45	0.27	13	21	11	1.3	0.52	0.18	0	2	13.46	15	2.89	
1.2	A. Roni		0-5 cm	34	9	57	3.5	3.4	4.09	0.32	13	60	12	0.52	0.29	0.23	0.03	1.07	16.56	6	3.92	
			5-20 cm	30	11	59	3.7	3.6	1.85	0.17	11	50	13	0.77	0.34	0.25	0.06	1.42	10.63	13	2.51	
1.2	Harahap		0-5 cm	34	15	51	3.7	3.6	3.95	0.28	14	57	23	0.67	0.29	0.27	0.03	1.26	18.03	7	5.21	
			5-20 cm	38	15	47	3.8	3.7	3.24	0.24	14	51	21	0.52	0.2	0.23	0.01	0.96	13.67	7	4.42	
1.2	H. Dur		0-5 cm	51	8	41	4.1	4	3.1	0.25	12	53	24	1.18	0.54	0.4	0.03	2.15	11.32	19	1.27	
			5-20 cm	54	10	36	4.1	4	2.26	0.18	13	47	11	0.47	0.19	0.17	0.04	0.81	6	14	1.76	
1.2	M. Lutan		0-5 cm	56	6	38	3.7	3.6	2.51	0.22	11	55	8	0.41	0.27	0.15	0.01	0.84	8.4	10	2.66	
			5-20 cm	52	7	41	3.9	3.8	2.17	0.16	14	47	8	0.31	0.2	0.12	0.01	0.64	9.28	7	2.55	
1.2	Taridi		0-5 cm	28	18	54	3.9	3.7	3.12	0.27	12	54	12	0.93	0.5	0.19	0.03	1.65	14.46	11	3.16	
			5-20 cm	42	15	43	3.8	3.7	1.35	0.13	10	43	12	0.71	0.42	0.19	0.01	1.33	7.31	18	2.53	
1.2	Yusuf		0-5 cm	52	17	31	3.9	3.6	2.55	0.21	12	71	12	0.62	0.29	0.19	0.04	1.14	12.53	9	6.36	
			5-20 cm	44	19	37	3.9	3.7	1.81	0.14	13	84	8	0.41	0.15	0.12	0.01	0.69	11.94	6	6.19	
1.3	M. Lutan	A.1	0-5 cm	54	5	41	4.7	3.5	3.04	0.23	13	52	9	0.67	0.32	0.15	0.01	1.15	10.07	11	1.85	
			5-20 cm	51	5	44	3.8	3.8	2.01	0.17	12	47	5	0.41	0.2	0.1	0.01	0.72	8.92	8	2.79	
1.3	M. Lutan	B.1	0-5 cm	56	6	38	4.1	3.9	2.55	0.33	8	50	12	0.51	0.32	0.17	0.01	1.01	7.42	14	2.5	
			5-20 cm	56	4	40	3.9	3.8	2.34	0.25	9	51	10	0.62	0.29	0.15	0.01	1.07	7.87	14	2.59	
1.3	M. Lutan	C.1	0-5 cm	51	7	42	3.8	3.6	2.65	0.21	13	55	10	0.31	0.25	0.15	0.03	0.74	7.93	9	3.45	
			5-20 cm	46	4	50	3.8	3.7	2.07	0.17	12	50	9	0.41	0.24	0.15	0.01	0.81	7.16	11	2.63	
1.3	M. Lutan	D.1	0-5 cm	47	5	48	3.9	3.7	3.29	0.22	15	20	8	0.46	0.24	0.12	0.02	0.85	10.55	8	3.72	
			5-20 cm	50	6	44	4.2	3.8	2.49	0.18	14	16	9	0.42	0.29	0.14	0	0.85	8.72	10	2.69	
1.3	M. Lutan	A.2	0-5 cm	42	4	54	3.7	3.6	4.36	0.32	14	59	10	0.67	0.36	0.19	0.03	1.25	12.59	10	4.28	
			5-20 cm	50	4	46	4	3.8	2.69	0.22	12	53	11	0.52	0.32	0.19	0.04	1.07	8.67	12	2.56	
1.3	M. Lutan	B.2	0-5 cm	54	5	41	4.2	3.9	4.73	0.24	20	63	23	2.28	1.4	0.29	0.01	3.98	14.29	28	1.82	
			5-20 cm	49	7	44	4	3.8	2.61	0.22	12	51	10	0.67	0.42	0.17	0.03	1.29	8.18	16	2.5	
1.3	M. Lutan	C.2	0-5 cm	52	5	43	4.4	3.9	2.62	0.19	14	17	9	0.41	0.42	16	0	0.99	8.82	11	1.83	
			5-20 cm	48	6	46	4.3	4	2.24	0.18	12	16	7	0.31	0.2	0.1	0	0.61	7.53	8	2.07	
1.3	M. Lutan	D.2	0-5 cm	52	7	41	4.3	3.8	2.44	0.21	12	16	9	0.51	0.37	0.14	0	1.02	7.55	14	1.93	
			5-20 cm	51	7	42	4.2	3.8	1.98	0.18	11	14	8	0.31	0.29	0.12	0	0.72	6.73	11	2.06	
2.2	Alias		0-5 cm	19	8	73	3.6	3.4	3.55	0.18	20	57	8	0.52	0.34	0.14	0.01	1.01	11.12	9	4.67	
			5-20 cm	16	8	76	3.6	3.5	3.4	0.27	13	57	8	0.83	0.32	0.16	0.01	1.32	12.14	11	3.85	
2.2	Adnan		0-5 cm	13	14	73	4.2	3.9	3.86	0.31	12	53	16	0.82	0.58	0.29	0.01	1.7	11.79	14	2.06	
			5-20 cm	13	12	75	3.8	3.7	2.3	0.23	10	122	8	0.62	0.38	0.14	0.01	1.15	11.15	10	3.11	
2.2	A. Yani		0-5 cm	31	33	36	3.7	3.5	4.07	0.27	15	53	10	1.44	0.61	0.15	0.01	2.21	13.27	17	3.54	
			5-20 cm	24	36	40	3.8	3.7	1.74	0.14	12	119	7	0.41	0.07	0.1	0.01	0.59	8.44	7	4.25	
2.2	Sabran		0-5 cm	13	16	71	3.6	3.4	4.39	0.43	10	66	10	1.2	0.41	0.16	0.01	1.78	17.21	10	5.08	
			5-20 cm	13	14	73	3.6	3.5	2.31	0.19	12	52	8	0.62	0.26	0.1	0.01	0.99	12.56	8	4.76	
2.2	Saer		0-5 cm	9	11	80	4.1	3.9	5.06	0.43	12	74	14	1.98	0.29	0.14	0	2.41	16.5	15	2.12	
			5-20 cm	6	9	85	3.9	3.8	2.33	0.21	11	56	9	2.65	0.61	0.19	0.01	3.46	10.16	34	2.28	
2.2	Sapri		0-5 cm	7	11	82	3.7	3.6	2.61	0.24	11	56	9	0.41	0.2	0.16	0	0.77	12.5	6	4.73	
			5-20 cm	7	9	84	3.6	3.5	2.37	0.22	11	59	8	0.41	0.2	0.1	0.01	0.72	11.06	7	4.47	
2.5	Alisri		0-5 cm	60	18	22	4.3	3.9	1.73	0.18	10	33	53	1.43	0.29	0.23	0.03	1.98	6.42	31	1.96	
			5-20 cm	60	13	27	4.5	4	2.11	0.15	14	38	53	1.43	0.4	0.5	0.04	2.37	7.84	30	1.35	
2.5	Effendi		0-5 cm	19	45	36	5	4.7	3.17	0.33	10	1.27	164	3.31	2.14	2.33	0.07	7.35	16.94	46	0.13	
			5-20 cm	16	39	45	4.4	4.1	3.03	0.28	11	106	39	2.08	1.37	0.47	0.03	3.95	14.53	27	0.94	
2.5	M. Noor		0-5 cm	8	30	62	4.4	4	4.37	0.34	13	98	19	1.32	1.25	0.3	0.03	2.9	14.75	20	1.52	
			5-20 cm	7	29	64	4.2	3.9	3.41	0.26	13	91	12	0.42	0.21	0.16	0.04	0.82	14.52	6	2.34	
2.5	SMTP		0-5 cm	14	28	58	4.3	4	5.69	0.41	14	119	23	1.82	0.8	0.31	0.04	2.97	16.73	18	2.37	
			5-20 cm	13	27	60	4.3	3.9	2.05	0.2	10	41	11	0.77	0.41	0.17	0.01	1.36	9.14	15	2.14	

Main results for West Sumatra

Main agronomic results of the RAS experimentation in West Sumatra

Main agronomic results of RAS on-farm experimentation network in East Pasaman area, West Sumatra, by Eric Penot, Dr Hisar Hihombing.

Introduction

West Sumatra is a relatively rich and diversified province with both rich landscape in the highland and very poor, degraded and hilly areas as in the northern tip of the province in the Kecamatan of East Pasaman (see map 1). Traditionally, in East-Pasaman local Minang farmers do have old jungle rubber close to rivers. The hills are burn every year and are covered with *Imperata cylindrica*. They have very few "sawah" , or irrigated rice fields, and still rely partly on shifting cultivation and rubber.
After a discussion with Pro-RLK staff[1], a GTZ local development project, it became obvious that RAS system might be a potential solution for these farmers. Preliminary discussions and a rapid survey enable us to select the villages of Bangkok and Lubbuk Gadang. Further limited means for logistic and monitoring force us to drop the second village, however we did provide to local farmers clonal planting material and information on RAS cropping patterns.

The output of the preliminary discussions with farmers lead us to select RAS 2.2 trial for this area where farmers have very limited capital, few land for their upland rice and very limited family labour. There is virtually no opportunity cost as they do not have access to local jobs in plantations as it is the case in other selected province. Soils are very depleted and chemically poor with slopes and very sensitive to erosion. The climate is equatorial with one main rainy season from October to March, with around 2 000 mm/year, but rainfall may be very erratic. The average altitude of the selected small watershed in Bangkok is 500 meters. All these factors leads to a very marginal situation in terms of suitability for rubber systems. Agroforestry with combination of intercrops and other perennial trees as well as soil conservation practices were essential to preserve the sustainability of rubber based cropping systems as well as optimizing the labour investment in relatively small plots. RAS 2.2 with upland rice and groundnut intercrops (with few palawijas) was chosen by farmers as it fit their own strategy. RAS 2.2 protocols (Penot 1995)are available in annex 1.

RAS 2.2 systems in West Sumatra

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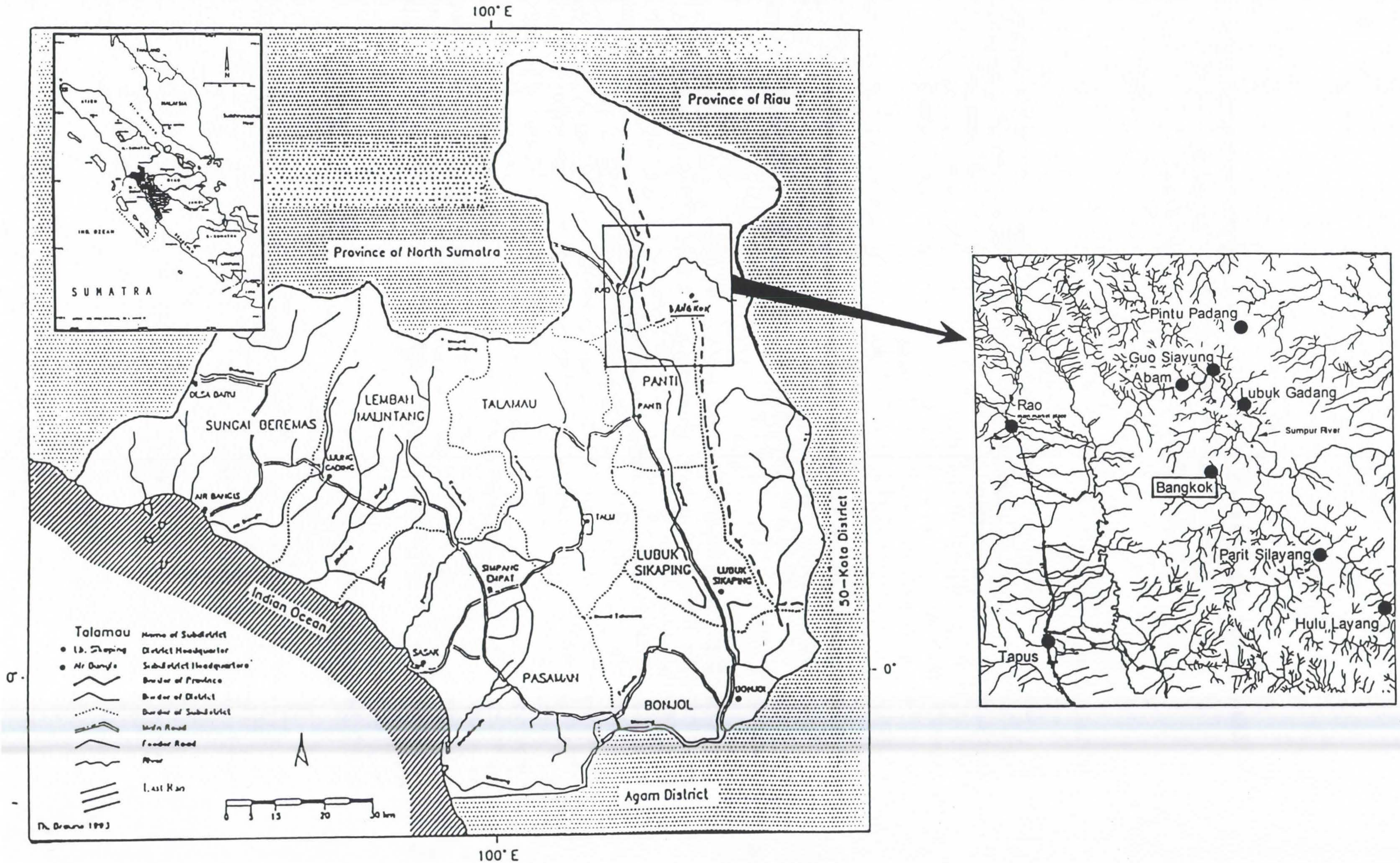
[1]We would like to thank here Mr Thomas Fairhurst and Ms Hellen Kramer, from GTZ, who supported right from the beginning the implementation of RAS in this area. Pro-RLK is a project aimed for rehabilitation of critical land.


100° E
Province of Riau
Province of North Sumatra
SUMATRA
SUNGAI BEREMAS
LEMBAH MALINTANG
TALAMAU
PANTI
LUBUK SIKAPING
PASAMAN
BONJOL
Indian Ocean
50-Kota District
Agam District
0°
Talamau Name of Subdistrict
District Headquarter
Subdistrict Headquarters
Border of Province
Border of District
Border of Subdistrict
Main Road
Feeder Road
River
0 5 15 20 30 km
Pintu Padang
Guo Siayung
Abam
Lubuk Gadang
Rao
Sumpur River
Bangkok
Parit Silayang
Hulu Layang
Tapus

3 trials, based on the same RAS 2.2 frame have been set up in order to find solution on 3 main topics : what type of fertilization ?, what type of planting material? and what type of intercrops ?. The trials protocols are available in annex 1.

RAS 2.2a
It is a trial aimed to identify the best fertilization amount adapted to the local conditions. 3 levels are being tried : 0 fertilization, 1 ton rock phosphate/ha at planting time[2] and complete NPK fertilization recommended by TCSDP, with 3 plots per replications (4 replications). Rubber fertilization is the only treatment. All plots are intercropped with rice and/or palawijas with an average fertilization (called BPS because it is recommended by BPS/SEmbawa).

RAS 2.2b
This trial is similar to that implemented in West Kalimantan where the treatments concerns the intercrop, upland rice, with the first treatment on the rice varieties (local vs improved high yielding) and the second treatment on rice fertilization level (0 and CRIFC dosis, recommended by CRIFC[3]), with 4 plots (4 replications).

RAS 2.2c
This trial compared clonal rubber (PB 260) with clonal seedlings (probably GT1 seedlings but sold as South Sumatra project BLIG planting material) and polyclonal seedlings (BLIG). BLIG (Bah Lias Isolated Garden) is a product from the London Sumatra Estate which is the only source of supply. The Pro-RLK project, in assistance with DISBUN[4], has distributed to local farmers BLIG planting material for nursing and plantations. This trial is aimed to identify the best adapted planting material to local conditions. Each replication has 3 plots (2 replications).

Clonal rubber vs BLIG for East Pasaman area : the type of improved planting material.

The improved rubber planting material may be divided in two main groups: the selected seedlings and the clones. Table 1 displays the characteristics of each type of planting material. To summarize : clones have the highest production potential and some very good secondary characteristics (such as resistance to diseases) but are more expensive, require more weeding and attention, a relatively high technical skill and a framework of budwood gardens and nurseries to supply farmers with budded stumps. Seedlings have the reputation of being more adapted to agroforestry conditions (at least for jungle rubber) with

[2]According to recommendations from Thomas Fairhurst, PPI (Potash and Phosphate Institute/Singapore, Pers Comm)

[3]CRIFC is the Center for Research in FoodCrops, Bogor.

[4]DISBUN or Dinas Perkebunan or Extension service for estate crops.

good growth, easy planting using seeds, and a low to medium cost according to the type of seedlings. However seedlings are very heterogeneous, leading to poor tapping management, and yields are low to medium. The current on Rubber Agroforestry systems in Jambi and West Kalimantan suggests that in similar agroforestry conditions, the selected clones grow as well as seedlings when clonal stumps in polybags are used.
We present in the following paragraphs the characteristics of 3 different types of planting material : unselected seedlings, polyclonal seedlings and clones.
A summary of these characteristics is presented in Table 2.

The unselected seedlings
The main characteristic of unselected seedlings is the high heterogeneity of trees in terms of production and disease resistance, which is common to all seedlings when compared with clones. Extensive surveys in the 1930's (Djikman) showed that 70 % of the production is given by only 30 % of the trees. Tapping labour and other potential costs (fertilization, weeding) are far less cost effective for this other 70 % of the trees. Heterogeneity in growth, production and susceptibility to diseases is a main features of all non-clonal planting material. The table 1 shows the expected variability of various type of planting material

Table 1. Evolution of different types of rubber planting material; their performance and cost of establishment per hectare

Year of availability and planting at commercial scale	YIELD/HA IN KG	Remarks
1910	325	unselected seedlings
1920	450	selected seedlings (thinning)
1926	725/775	mother tree seedlings and better cultural practices
1930	1350-1400	first generation of clones TJIR 1 type
1950-60	1500-1700	second generation of clones (PR 107 type)
1980	1700-2000	third generation of clones (PB 260 type)

Source : (Djikman 1951), (Penot and Aswar 1994)

TABLE 2 : Main characteristics of different types of rubber planting material

planting material	ADVANTAGES	DISADVANTAGES
UNSELECTED SEEDLINGS USS	good growth, low cost relatively good adaptability to local conditions, good availability	very low productivity : 350 to 500 kg/ha, heterogeneity in production and resistance to diseases (seedling population).
Mother tree seedlings MTS	good growth medium cost (selection) relatively good adaptability to local conditions no longer available	medium to high productivity (according to level of selection): 700 to 1500 kg/ha, heterogeneity (seedling population)
clonal seedlings ICS	good growth, low cost relatively good adaptability to local conditions good availability for ICS from current clones	low productivity : 500 to 700 kg/ha, heterogeneity (seedling population)
polyclonal seedlings PCS	good growth medium cost (BLIG), (according to level of thinning). relatively good adaptability to local conditions	medium productivity : 1000 to 1500 kg/ha no specific leaf diseases resistance. heterogeneity low availability (from LONSUM only), requires high level of thinning as expensive as clones if well thinned (high selection
CLONES (typology of clones)	slow to very good growth medium to high productivity : 1500-2000 kg/ha homogeneity resistance or susceptibility to various diseases (clonal typology) labour saving for tapping possible sale of rubber wood as valuable timber.	requires grafting clonal purity should be maintained requires a minimum level of weeding. necessary to select clones suited to the local environment. more susceptible to diseases if monoclonal plantation (more risks in small size plantations) expensive if not produced by smallholder themselves

The clonal seedlings

These seedlings are obtained through the collect of existing clonal plantation seeds. Dijkman assessed that by the 1950's(Djikman 1951), most of the farmers in North Sumatra in fact used clonal seedlings collected from estates, as many of the workers established their own plantations in the surrounding areas. This is probably true for that particular province but not for other provinces where estates, and therefore sources of clonal seedlings were scarce. Farmers, thus, have to rely on seeds collected in existing jungle rubber. It is however clear that after a century of rubber seed dissemination all over Sumatra and Kalimantan, the current population of local seedlings is partly based on clonal seeds.

We have no clear data on performance of clones planted by smallholders except for SRDP project. The only indication is that the yield of smallholders is higher in North Sumatra than in the other provinces as suggested by DGE statistics ((DGE 1996)). But farmers have also planted a lot of clonal plantations in that province, so from current statistics it is not possible to distinguish yields of clonal seedling plantations, from jungle rubber or from clonal plantations..

Studies have been made to compare clones and the performance of their related clonal seedlings. One has to keep in mind that all these trials and comparison made in the 1930's and 40's were based on the first or second, generation of clones, which generally have relatively poor yields (around 1 000 to 1 500 kg/ha/year) as shown in Table 3 (average figures for Malaysia in the 1930's).

Table 3

YIELD COMPARISON BETWEEN CLONES AND SEEDLINGS IN MALAYSIA

In inland estates trials ***MEAN YIELD OVER 5 YEARS***

TYPE OF IMPROVED PLANTING MATERIAL	Inland	Coastal
	ESTATES	ESTATES
CLONES	1414	1220
CLONAL SEEDLINGS	1132	954
in % of clones	0.8	78%

Tapping system : D/2

Source : (Burkill 1952)

A study has been conducted at the IRRI station of Sembawa in South Sumatra (Delabarre M. 1987) on GT1 clonal seedlings (1315 trees) in the 1980's. The heterogeneity of production of this planting material (GT1 ill.) is high as for all seedling populations. 20 % of the trees gave 44 % of total production. The average yield was 1183 kg/ha for a D/2 tapping frequency (150 tapping/year, similar to farmers practices). Such a high tapping frequency increases the risk of brown bast disease on the tapping panel, leading to a serious decrease in production of the highest yielding trees (up to 20 % of the trees). This is equivalent to a loss of 25 % of the potential yield without brown blast, estimated at 1577 kg/ha). Such yields have been obtained with rigorous thinning and selection of seedlings at planting time. We should acknowledge that in reality, farmers never practice such selection and usually plant every available seedling into the field. Therefore, it is an illusion to expect high yields from clonal seedlings in smallholder conditions. The same conclusion can be drawn with polyclonal seedlings.

The polyclonal seedlings

Polyclonal seedlings are obtained by collecting seeds in polyclonal isolated gardens. North Sumatra estates used to plant this type of planting material up to the 1960's (in particular "PBIG" from the Prang Besar Estate in Malaysia). During the same period, farmers never had access to such planting material. The first series of polyclonal seedlings show low yields (maximum of 800 kg/ha/year) compared to first generation clones such as TJIR 1, and yields far below clones such as PB 260 (third generation). The average yield of BLIG compared to other clones is shown in Figure 1 and table 4.

The current existing source of polyclonal seedlings in Indonesia

The only current source of polyclonal seedlings, BLIG (Bah Lias Isolated Garden), is located in North Sumatra at London Sumatra Estate. This estate is still advocating the use of BLIG, however this company itself is no longer planting BLIG for latex production, but for rubber wood production. Ease of planting (seeds) and a theoretically low cost (assuming no selection, and one seed produces one satisfactory plant) are cited as being the main advantages of BLIG. BLIG is the only real polyclonal seedling type available in Indonesia. This monopoly situation is therefore very dangerous for suppliers, and the supply itself is very limited indeed, as BLIG gardens hectarage is only 5 hectares. However, good yields can be obtained only with a severe thinning in both nursery and the fields, which leads to the use of more seeds required per tree in the field. In that case, BLIG is a planting material that is as expensive (if not more), than clones. Yields of BLIG or PBIG recorded in estates (LONDON SUMATRA) include a very severe thinning policy that is never likely to be the case with smallholders.

Figure 1

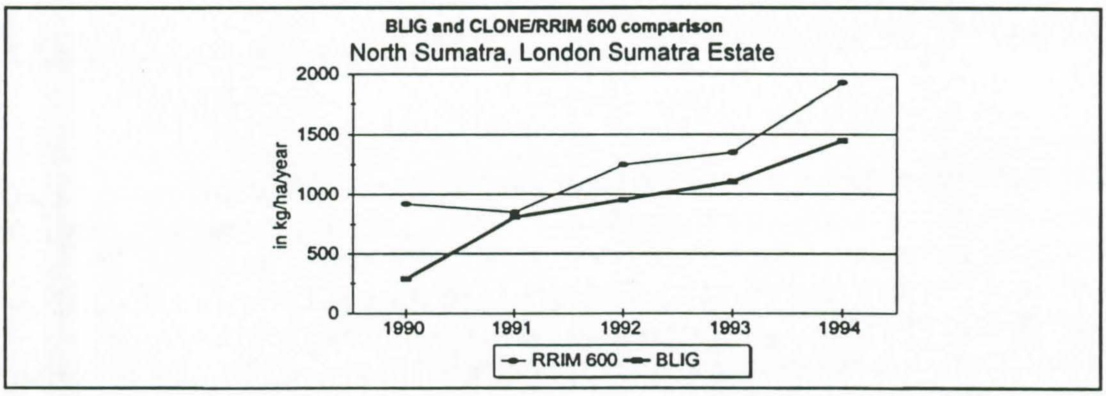


Table 4 ***PRODUCTION OF BLIG COMPARED TO CLONES AT PT. London Sumatra NORTH SUMATRA***

Location	Year of planting		Number of trees		production in kg/ha/year						
	planting	material	Total	producing	1990	1991	1992	1993	1994	**Production accumulated**	in % of clone
Sei Rumbia (Sumut)	1984	BLIG	356	354	**244**	**865**	**1142**	**1187**	**831**		
Palang Isang (Sulsel)	1985	RRIM 600	381	363	**921**	**852**	**1249**	**1349**	**1928**	6299	
	1986	BLIG	391	391	**286**	**810**	**952**	**1105**	**1445**	4598	**73%**
	1987	BLIG	401	393		**241**	**666**	**932**	**1249**		'65 %
		GT1	402	389			**594**	**1309**	**1957**		
	1988	BLIG	409	390				**465**	**1001**		
	1989	BLIG	419	408				**421**	**774**		
	1990	BLIG	436	348					**331**		

*) Data from Palang Isang estate
**) Data obtained in December 1994
Source: Pusat Penelitian Karet, IRRI, 1995

The clones

The first budding occurred in North Sumatra in 1916. In 1936, as many as 175 000 ha where planted with first generation clones in Sumatra. Budding does not totally suppress the genotypic variability, but seriously reduces it (normally to less than 25 %) . Using homogeneous clones increases cost effectiveness of any input investment, as all trees will profit from it. Budding also does not transfer the full performance of the mother tree. That is the reason why it is necessary to test new clones for at least 15 years to confirm their performance and stability. The comparison between clones and improved seedlings, up to the 1940s', has been based on these first generation clones. These clones were not as high yielding as now and generally had quite poor secondary characteristics.

The first properly tested clones began to be available in 1934 in North Sumatra and West Java. The current clones, of the third generation, have excellent performances both in estates and in smallholding according to clones typology. Most of them have the following characteristics : precocity (PB 260 is tapped at 3,. years of age at the Goodyear estate in perfect conditions, but most of them can be opened at 5 years old), very good vigour and growth (PB 260 and RRIC 100), high-yield (1800- 2000 kg/ha for PB 260, 1700 kg for GT 1 in smallholding in South-Sumatra, (Penot, 1993), and good resistance to leaf diseases.

The homogeneity of clones enables good tapping and good bark renewal, assuring a long production potential. Eventually, the frequency of tapping can be reduced to D3[5] without any production loss (and without use of stimulation) with clones like PB 260 and RRIC 100, leading to significant labour saving (33 % in the case of D3). The use of stimulant can even reduce the tapping frequency to D/4, if high labour costs necessitate this. Using clones gives the farmers room for further improvement in labour productivity, as well as a better final income from the rubber wood sales at the end of the plantation. This is not the case with seedlings, due to their conically shaped trunk (the wood can only be sold as firewood at a much lower price). One hectare of clonal trees may produce an average of 200 m3 of wood for timber or pulp.

Productivity versus cost : improved planting material adoption

This trade-off is quite clear : clonal rubber adoption means high productivity, but also a higher cost of investment in terms of inputs and labour than jungle rubber, if planted either in monoculture or in RAS systems.
The cost of clones produced by farmers, or purchased from private nurseries (210 to 270 000 Rp), and that of BLIG (324 000 Rp assuming a medium level of selection) is within the same range. The advantage still goes to clones in that case for 2 reasons : cost is lower than that of BLIG (if BLIG is selected in the nursery), the supply of clones is better in most locations, and production as well as adaptation to local conditions is more efficient. On the other hand, in the case of polybagged clones supplied by a local private nursery (market price), the cost of clones is twice that of BLIG. However clones have the advantage of better productivity, homogeneity in production, labour saving during tapping and better leaf disease resistance (if the clone is well selected to local environment), although more weeding,, and therefore more labour during immature period is required.

[5] D/3 means a tapping frequency based on 3 days.

Table 5 : Cost of IGPM in a new plantation

IGPM	Cost per unit in Rp	Number of plants for 1 ha of plantation	Total cost of IGPM for 1 ha in rupiah
unselected seedlings (seeds) Jungle rubber	0	1000	0
clonal seedlings 4 seeds per planted tree	12.5	600 x 4 seeds	30 000
PCS (BLIG) 3 seeds for 1 planted tree no selection (transportation cost not included)	90	600 x 3 seeds	162 000
PCS (BLIG) 6 seeds per planted tree Medium level of thinning (transportation cost not included)	90	600 X 6 seeds	324 000
clone (produced by the farmers) 4 GT1 seeds = 50 Rp Grafting = 100 Rp budwood = 100 Rp Miscellaneous = 100 Rp	350 in polybag	600	210 000
clone : stump bought at private nursery and put into polybag 350 Rp/stump + 100 Rp/Polybag	450 in polybag	600	270 000
clone (produced by private nurseries)	1000 in polybag	600	600 000

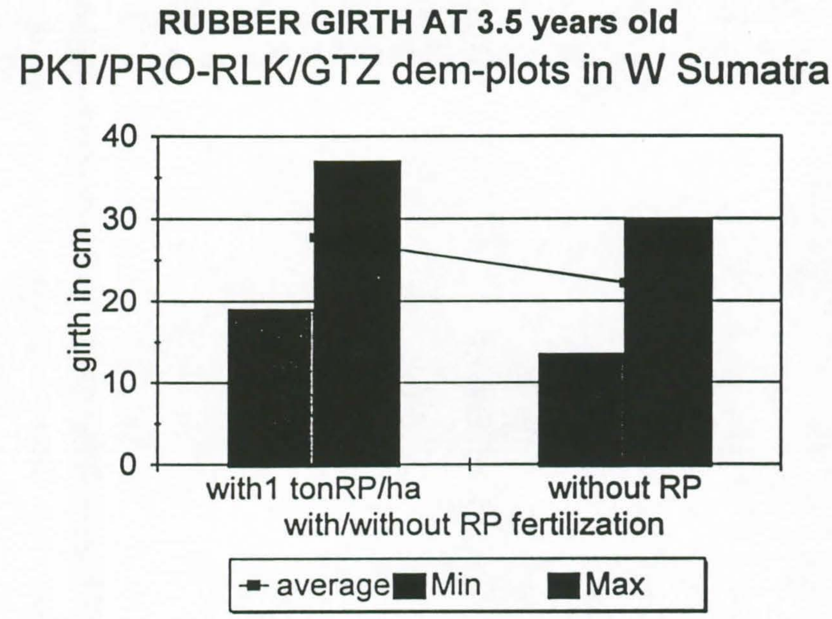
Number of rubber trees required for 1 ha = 550 + 10 % for replacement = 600.

Budded stumps can be purchased by farmers and planted in polybag in farmers' small nurseries without any technical problems. But the farmer has still to rely on clonal purity guaranteed only by the private operator, without any control or official certification which may lead to problems as farmers do not have any control over quality. The cost effectiveness is very low if the farmer is paying a high price for planting material which is no better than unselected seedlings. Budded stumps do not necessarily mean they are clones (the case of stumps budded with non clonal budwood). Therefore clonal purity should be guaranteed to farmers.

The level of production of BLIG will mainly depend on the level of selection through thinning. Generally, farmers will try to plant most of the stumps produced from purchased seeds, and we may expect in practice to have a very low level of thinning, leading to a lower production (probably around 1 000 kg/ha or less). In that case, of course the cost of seeds is lower (3 seeds per tree planted only). A better production might be expected, at least for the first 4 years (but no sufficient information after that period) with a medium level of thinning (estimated with a minimum 6 seeds per planted tree). The supply of BLIG is problematic: only two sources in North and South Sumatra. Transportation and seed viability (only 3 weeks after harvest) are very serious limitations.

So far, farmers' decisions about the type of planting material they use is highly dependent on income. According to a survey in South Sumatra (Gouyon 1995), 45 % of the farmers still use unselected seedlings , 22 % use GT1 seedlings for jungle rubber planting and 32 % use clones (60 % if income is above 5 millions Rp/year in 1990). It is also dependent on access to planting material and presence of estates, rubber projects or private nurseries. In South-Sumatra in remote villages (still considered as pioneer zones), the clone use rate is 1,5 %. In villages close to estates or PTP or private nurseries, the rate is 32 % (A Gouyon, 1995).

figure 2



P fertilization for rubber

The first 2 years are critical in term of growth for rubber in such conditions. It is therefore necessary to determine the best combination of labour and inputs levels. For achieving optimal in terms of cash and labour availability, fertilization is the second largest input that may overcome poor soil fertility and boost rubber growth. Among the key nutrients, it seems that P is the main factor.

A PKT/ProRlk/GTZ demonstration plot established in West-Sumatra in 1993 shows evidence of a significant effect of 1 ton rock phosphate/ha at planting time on rubber growth (see figure 2, source : (Penot, Fairhurst et al. 1996)).

Rubber Immature period in rubber based cropping systems: a window for food cropping. The secondary effect on rubber growth of intercrop fertilization has been previously demonstrated. Experimentation is being conducted in order to identify the most well adapted rice varieties (local and improved) and the most economic fertilization levels. In West-Kalimantan the rice varieties were : for High Yielding Varieties (HYV) : Wayrarem, and Jatiluhur , for the local variety : Saim (from Sembawa/South Sumatra) : with 2 levels of fertilization (0, and CRIFC Dose 150/250/100 kg of urea/SP 36/KCL per ha). This level is the recommended level by CRIFC. Preliminary results indicates that production of rice and palawija intercropped during the first 3 or 4 years, may be maintained only with a sufficient crop fertilization. Risk of crop failure due to blast and insect damage is relatively high. Without crop protection, rice yields are still low and may not pay off the cost of fertilization . It seems also that on poor soils such as leached yellow/red ferralitic soils in West-Kalimantan and West-Sumatra, the establishment of covercrops (in RAS 3) without P is not possible (current dose is 500 kg RP/ha). This may also explain farmers' reluctance to use nitrogen fixing covercrops. Fertilization at economic levels, such as those recommended by TCSDP for the first 3 years[6] only, or the supply of a high amount of P at planting time may be sufficient to enable rubber to grow satisfactorily in such competitive agroforestry environments.

The establishment of rubber based agroforestry systems which are appropriate to local financial labour and environmental conditions must, therefore, prioritize, firstly, the use of improved planting material[7] and, at a minimum, Phosphorus fertilization.

Participatory approach is a key tool in farmer's innovations adoption process and is part of SRAP methodology.

Assessment of farmers feedback through the implementation of research and an understanding of innovations adoption process are necessary to ensure high adoption levels of the rubber systems currently tested.

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[6]TCSDP = Tree Crop Smallholder Development Project recommendations are : 200 grams RP/tree planting time and 50 grams urea, 40 grams SP 36 and 40 grams KCL per tree every 3 months.

[7]Rubber clones have been selected for good growth, high yields and resistance to leaf diseases as well as farmers tapping methods. These clones are PB 260, RRIC 100, BPM 1 and RRIM 600.

MAIN OUTPUTS

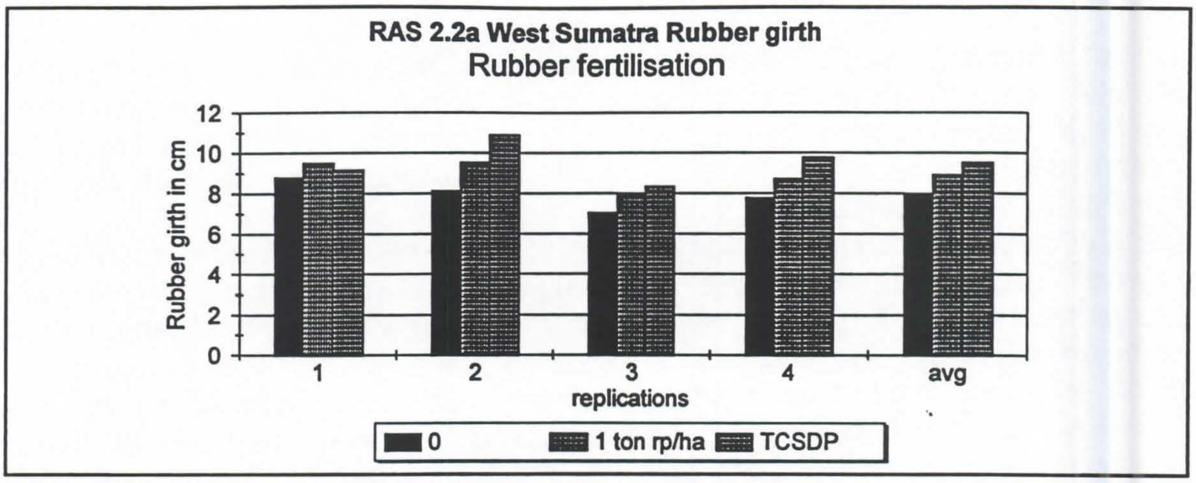
One of the main feature of RAS implementation in East Pasaman , located in a relatively remote and marginal area is that local farmers have right from the beginning followed the protocols, defined together between scientists and farmers, and managed particularly well their rubber gardens. All the 8 plots are located in a small watershed that was previously covered by *Imperata* grass.
Initially , planting occurs in January 1996, in the middle of the rainy season. Rainfall are relatively erratic in this area. 3 weeks of drought after planting led to a high percentage of stump mortality and "normal" replacement (10 %) was obviously not sufficient. A complementary planting occurs in September/October 1996 to complete the missing plants. Rice cropping in 195/96 with local varieties has also no been successful, as well as the 1996/1997 local I rice cropping. Eventually, according to farmers decision, it has been decide to use a more promising South Sumatra local variety ("Saim", suggested by G Wibawa from BPS/Sembawa) and a High Yielding Variety (HYV) : Jatiluhur. In 1997, rice cropping became successful. farmers do weed very properly their upland rice crop leading to a very good weed management for both intercrops, rubber and associated trees. Contrary to other zones , and especially in West Kalimantan, very few associated trees died. Due to big slopes, all plots have protective contour line with *Flemingia congesta* in order to limit erosion during rubber immature period.

It should also be mentioned that local farmers are familiar with both BLIG and clonal planting material as respectively Pro-RLK/DISBUN and PKT/DISBUN previously provided them with such planting material though small scale projects. The fact that farmers do know pros and cons of clonal rubber versus seedlings (as that used in jungle rubber) is clearly an advantage for further adoption of RAS system. The same remark can be done concerning the anti-erosion contour line systems using Flemingia as pro-RLK did introduce it in the area several years before. Therefore , local farmers had the opportunity to see the potential and efficiency of such planting material or cultural practices, leading to a more rapid adoption and effective implementation in the fields.

RAS 2.2a

There is an effect of fertilization on rubber (figure 3) however these differences are not statistically significative, at least for the first 22 months. That low effect of fertilization, related to poor soils, might be explained by the fact that a part of the fertilizers may disappear through the combination of aggressive rainfall and big slopes before the proper establishment of the protective contour line with *Flemingia congesta*. This confirms the fertilization effect observed in the PKT plots (figure 2).

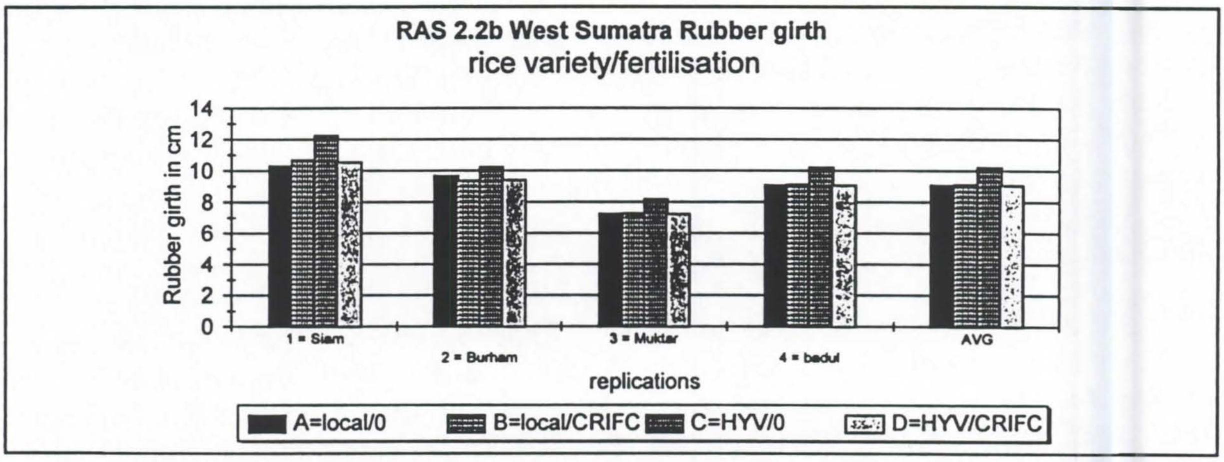
Figure 3



RAS 2.2 b

There is no clear effect of the combination rice variety/fertilization on rubber growth and it seems that the fertilizers applied on the intercrop do not have a significant effect on rubber growth for the first 22 months. That confirms the same conclusion for a similar type of trials in West Kalimantan (see paper 2).

Figure 4



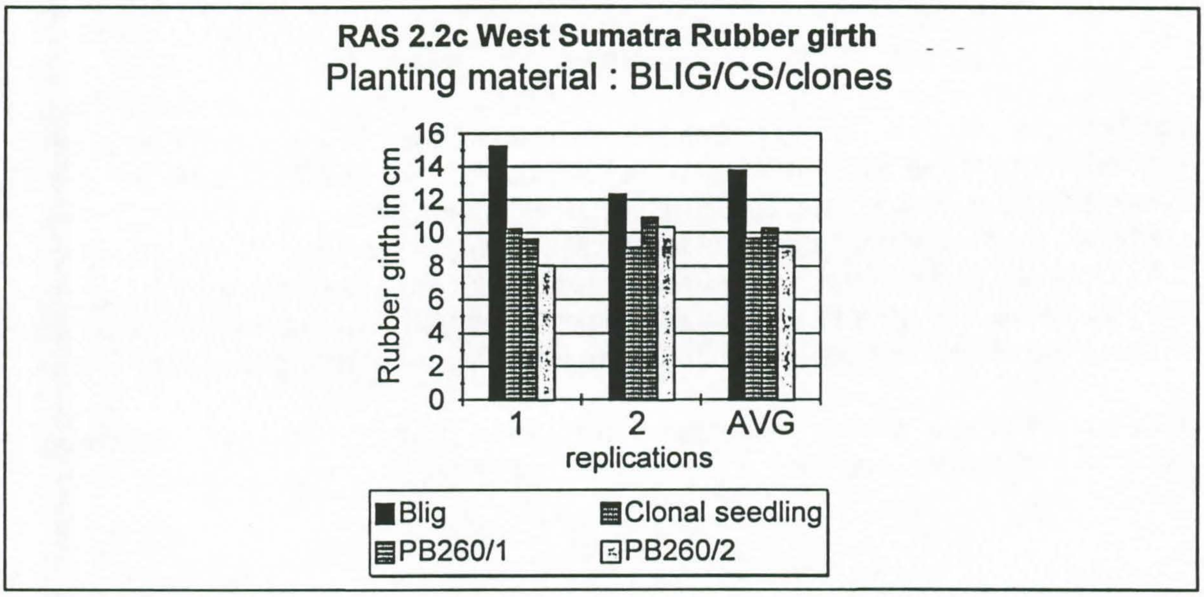
RAS 2.2c

In this trial, we can clearly observed that BLIG growth is faster than clonal rubber (PB 260) and even clonal seedlings (probably GT1 seedlings). BLIG has always been acknowledged

as a fast growing seedling planting material. London Sumatra Estate is using BLIG for intercropping planting material (for wood production) in between clonal rubber (for latex production). Therefore, the potential of BLIG is more used for its biomass production rather than its latex potential production which is insufficiently known in the long term.
In RAS 2.2 with intercrops and such good weed management as observed on all plots, this good growth for BLIG is not specifically an advantage as it would have been in RAS 1 system where rubber compete with secondary forest regrowth. It is also clear than the use of BLIG, as seeds and not as grafted stumps like clones , is more easy and handable by farmers. However , we do not have enough clear indication that the production potential is sufficient compared to that of clones. BLIG is also not anymore available on the market as the total production is currently being used by London Sumatra. This very low availability , the situation of monopoly for production of the seeds, and the uncertainty on BLIG future lead to advocate in favour of clones.

In conclusion, the apparent better growth of BLIG, expected as seedlings generally grow faster than clones, may not be considered as a major advantage, but should be noticed. Further observations, and in particular resistance to leaf disease (in particular *Colletotrichum*) should be observed.

Figure 5

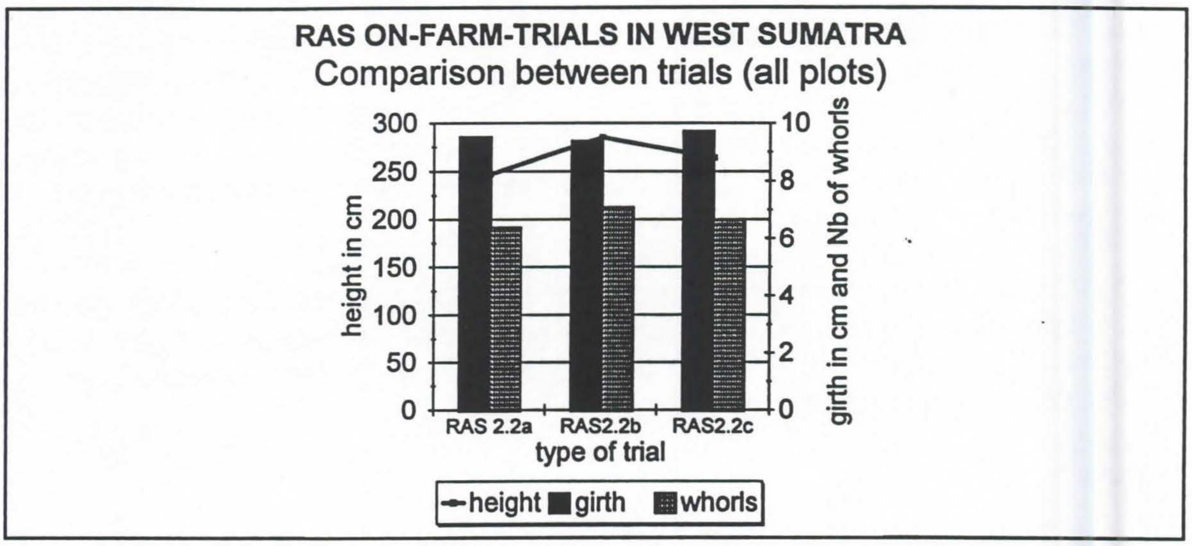


Conclusion

RAS 2 implementation is undoubtly a real success in East Pasaman with farmers providing the best possible management on their rubber trial fields.

If we look to figure 6 that displays rubber growth for all RAS trials using clonal rubber (excluding the plots without fertilization or using BLIG of clonal seedlings), we see a very good homogeneity between trials demonstrating a similar management of the trials according to intercropping and weeding.

Figure 6



There is a very good indication on the potential of adoption of such system in the area with the example of Lubuk Gadang village. In this last village , SRAP did supply a selection of farmers with clones and information on RAS but no further efforts were provided as this village has been abandoned by SRAP. Local extension, though the Pro-RLK/GTZ project, continues to provide only a general technical information service. 22 months after planting, RAS plots are well maintained and are as successful as in Bangkok with the determination of local farmers to adopt an obviously adapted cropping system that fits local conditions ,without the relatively heavy monitoring as it has the case in the Bangkok village.

This observation is very promising both for further development and adoption of RAS 2 systems in the area, and for the successful rehabilitation of very degraded lands.

Bibliography

Burkill, H. M. (1952). *"Large scale variety trials of Hevea brasiliensis Muell-Arg on Malayan estates."* Conference of Rubber Research Institutes in the Far East, Bogor, Indonesia.

Delabarre M., S. M. N. (1987). *"Production of improved rubber seedlings."* BPS/Sembawa, unpublished , pers comm.

DGE (1996). *Stastistik karet (rubber)*. Jakarta, Indonesia, Ministry of Agriculture.

Djikman, J., Ed. (1951). *30 years of rubber research.*, University of Miami, USA.

Gouyon, A. (1995). *Paysannerie et heveaculture dans les plaines orientales de Sumatra : quel avenir pour les systemes agroforestiers* ? Paris, INA-PG.

Penot, E. (1995). *West Kalimantan mission report number 2, 18-29 July 1995. RAS on farm experimentation sites selection in the west Kalimantan province.* October trial planting compaign. Bogor (IDN), : ICRAF, n.p. (70 p.), tabl.

Penot, E. and R. Aswar (1994). *Rubber clones index in Indonesia.* Sembawa (IDN), IRRI, . - n.p. (400 p.) : ill., 39 r f., tabl., graph.

Penot, E., Fairhurst, et al. (1996). *Rock phosphate plays a key role in the establishment of rubber based agroforestry systems in Indonesia.* International conference on nutrient management for sustainable foodcrops production in Southeast Asia,, Bali.

RAS protocols in West Sumatra

RAS 2.2a TRIAL PROTOCOL

RUBBER + associated trees + intercropping

RUBBER FERTILIZATION

West-Sumatra province
East Pasaman

RAS METHODOLOGY

RAS 2.2a TRIAL PROTOCOL
RUBBER + associated trees + intercropping
RUBBER FERTILIZATION

TITLE

Clonal rubber in agroforestry environment : rubber + selected associated trees + intercropping / TREATMENT ON RUBBER FERTILIZATION

OBJECTIVE/HYPOTHESE
OBJECTIVES

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate usefull trees (fruits and timber trees) with rubber, at a limited planting density, without subtantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.
In that case, fertilization of rubber may be a key factor in the trade-off between fertilization and level of weeding. In thecase of East Pasaman area where fields are continously cropped, weeding is not anymore a key factor as rubber tres are well weeded. The critical situation of the land : slope with high risk of erosion , poor soils , erractic rainfall and local severe drought during dry season as well as altitude implies that rubber should grow very fast during early stage after planting.
This trial is aimed to compare 3 level of fertilization on clonal rubber in RAS 2.2 system.

Hypotheses :

General hypotheses for RAS 2.2 :
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generaly a slow growth pattern (in partticular for durian , local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber imature period will create a favourable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.

Specifically for RAS 2.2A in West-Sumatra :
- We do not know in the specific conditions of West-Sumatra if rubber need fertilization or not, and a which level.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2 :
- rubber fertilization management required for successful growth of rubber clone in this environment

LOCATION : WEST SUMATRA , East Pasaman, village of Bankok

YEAR :
planting of rubber :
first planting : January 1996
Replanting : october 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees : **on all plots.**

Treatments : on rubber fertilization

- PLOT A : "0 fertilization",

- PLOT B : " application of high amount of Rock Phosphate (RP) at planting time only (1 ton /ha or RP, 27.5 % in the planting hole and 72.5 % broadcast in the field at planting time)

So - in theplanting hole : 500 grams per trees (275 kg/ha)
  - broadcast in the field at planting time : 725 kg/ha

- PLOT C : complete TCSDP fertilization programme for the first 2 years with RP at planting time and NPK fertilisation every 3 months).

TCSDP fertilization programme is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
UREA		50	50	50	50
SP36		40	40	40	40
KCL			40	40	40

TCSDP fertilization is supplied for the first 2 years only.

EXPERIMENTAL DESIGN
Randomized block system
2 replications per farm.
2 farms
Total number of replication : 4 rep.

RUBBER
All rep are planted with RRIC 100.

FERTILIZATION

PLOT A : O fertilisation.
PLOT B : RP only at planting time
PLOT C : TCSDP fertilization programme only for the first 2 years. No fertilization later.

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :

6 weedings ayear , every 2 months, on a regular basis. Local observation and presence of alang²
may change that pattern.

INTERCROPPING

RAINY SEASON

Rice is not a treament is this trial. The same variety with the same amount for fertilization is cropped in all the field.
Local rice has been planted in 1995/96 without fertilization.
Local rice has been planted in 1996/97 without fertilization.

FOR 1997 :

Rice will be planted in september 1997 : improved rice + recommended BPS/Sembawa fertilisation (100 kg urea + 130 kg SP 36 + 75 kg KCL). Urea is provided in 3 periods : planting time, + 40 days and + 80 days after planting.
Chemical treatment againts pests and diseases.
Weeding : 2 weedings during growth.

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
BPS	100	160	75

Urea is supplied in 3 times : 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

1998 : similar to that of 1997 according to shading situation.

DRY SEASON

According to farmers strategy: nothing or palawijas : such as groundnut which is the best inter crop for dry season.

No fertilization.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees acccording to local situation. The associated trees frame should be the same for all trials, or similar.
Weeding : same as for rubber (6 weedings/year).

RAS 2.2a protocol

FIELD SIZE per farm

PLOT SIZE : 1000 m²
NUMBER OF PLOTS PER REPLICATION : 3 plots
NUMBER OF REPLICATION/farm : 2
NUMBER of FAMS : 2
REPLICATION/FARM SIZE : 6 plots : 6 000 m²

TOTAL SIZE OF THE TRIAL : 1.2 ha with 2 farmers
Total number of replication : 4

DATA TO BE COLLECTED

Standart data for all RAS 2.2 :

RUBBER

- rubber growth measurements : diameter, height and worls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot (according to field maps).
- Farmer's labour for each plot.
- soil samples per replication on 0-15 and 15-30 cm.

Total number of soil samples for the 2 farms : 6 plots x 2 rep x 2 soil depths = 24

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of each plot with a sample of 100 grams to be sent to ICRAF/Bogor for water content measurement.

Labour requirement per plot, recorded by farmers and controled by PPL.

RAS 2.2b TRIAL PROTOCOL

RUBBER + associated trees + intercropping
RICE EXPERIMENTATION : VARIETY X FERTILIZATION

West-Sumatra
East Pasaman

RAS METHODOLOGY

RAS 2.2b TRIAL PROTOCOL
RUBBER + associated trees + intercropping
RICE EXPERIMENTATION : VARIETY X FERTILIZATION

TITLE

Clonal rubber in agroforestry environment : rubber + selected associated trees + intercropping / TREATMENT ON RICE VARIETIES AND AMOUNT OF FERTILIZATION.

OBJECTIVE/HYPOTHESE
OBJECTIVES

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate usefull trees (fruits and timber trees) with rubber, at a limited planting density, without subtantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.
Rice intercropping provides to rubber a indirect good weeding management and good conditions for growth. The objective is to optimize in farmers conditions rice cropping with the best adapated technological package adoptable by local farmers

Hypotheses

General hypothese for RAS 2.2 :
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generaly a slow growth pattern (in partticular for durian , local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber imature period will create a favourable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.
- there is an indirect benefit of rice fertilization on rubber.

Specific for RAS 2.2 b :
- We do not know in the specific conditions of West-Sumatra what are the best adapted rice varieties and their management (weedings and fertilization) as well as the best adapted crop rotation.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2 :
- Rice varieties, fertilization level and rotation (with palawijas).

RAS 2.2b/Augustus 1996

LOCATION : WEST SUMATRA , East Pasaman, village of Bankok

YEAR :
planting of rubber :
-January 1996
- Replanting : October 96

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees on all plots.

DRAFT
Treatments : A (rice varieties) x B (fertilization level):

Treatment A
- local rice or improved rice : + 0 fertilisation.

Treament B
- Local rice or improved rice + recommended CRIFC fertilization programme. -

Treatment C
- Improved rice (wayararem/Jatiluhur) + 0 fertilization

Treatment D
- Improved rice (Wayararem/Jatiluhur) + recommended CRIFC fertilization programme.

Urea is provided in 3 periods : planting time, + 40 days and + 80 days after planting.
Chemical treatment againts pests and diseases.
Weeding : 2 weedings during growth.

"CRIFC fertilization dose" is the dose recommended by CRIFC/Bogor for JAMBI.
FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
CRIFC	150	220	150

EXPERIMENTAL DESIGN
Randomized block system with 2 treatments : variety x fertilization

1 replication per farm. 4 plots per farm
4 farms
Total number of replication : 4 rep.
All rep are planted with PB 260

RUBBER
FERTILIZATION of RUBBER
TCSDP fertilization programme only for the first 2 years. No fertilization later.

TCSDP fertilization programme is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
UREA		50	50	50	50
SP36		40	40	40	40
KCL			40	40	40

The amount of each fertilizer to be supplied to the plots is calculated in anex for each farmer and for each plot.

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :
6 weedings ayear , every 2 months, on a regular basis. Local observation and presence of alang^{2} may change that pattern.

INTERCROPPING

RAINY SEASON
See treatments ON RICE

DRY SEASON

According to farmers strategy: nothing or palawijas : such as groundnut which is the best inter crop for dry season.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees acccording to local situation. The associated trees frame should be the same for all trials, or similar.
Weeding : same as for rubber (6 weedings/year).

FIELD SIZE per farm

PLOT SIZE : 1000 m²
NUMBER OF PLOTS PER REPLICATION : 4 plots
NUMBER OF REPLICATION/farm : 1
REPLICATION/FARM SIZE : 4 plots : 4 000 m²
Number of farms : 4
TOTAL SIZE OF THE TRIAL : 1.6 ha with 4 farmers
Total number of replication : 4

DATA TO BE COLLECTED

Standart data for all RAS 2.2 :

RUBBER

- rubber growth measurements : diameter, height and worls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labour for each plot.
- soil samples per replication on 0-15 and 15-30 cm.

Total number of soil samples for the 2 farms : 4 plots x 2 rep x 2 soil depths = 16 (Badul and Muktar)
2 fields x 2 soild depth = 4 (siam and Burham)
Total = 20

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of each plot with a rice sample of 100 grams to be sent to Bogor to control the water content

Labour requirement per plot.

RAS 2.2c TRIAL PROTOCOL

RUBBER + associated trees + intercropping

COMPARISON CLONAL RUBBER AND POLYCLONAL SEEDLINGS (BLIG)

RAS METHODOLOGY

RAS 2.2c TRIAL PROTOCOL
RUBBER + associated trees + intercropping
COMPARISON CLONAL RUBBER AND POLYCLONAL SEEDLINGS (BLIG)

TITLE
Clonal rubber in agroforestry environment : rubber + selected associated trees + intercropping / Comparison between rubber planting material : Clone vs bLIG

OBJECTIVE/HYPOTHESE
OBJECTIVES

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate usefull trees (fruits and timber trees) with rubber, at a limited planting density, without subtantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.
Various type of rubber planting material are available in particular clones and BLIG (polyclonal seedlings from North and South-Sumatra) : the aim is to do a comparison between rubber planting material : rubber clone vs bLIG (polyclonal seedlings from LONDON SUMATRA, North Sumatra). BLIG is a polyclonal seedlings from the Bah Lias Isolated Garden.

Hypotheses

- Clonal rubber requires more weeding and maintainance that polyclonal seedlings.
- Use of polyclonal rubber seeds is less expensive that clones and easier to use (direct planting).
- The selected clones are resistant to leaf diseases as BLIG seems to be very susceptible (as it has been observed in West-Pasaman).
- Clones productivity is higher that that of polyclonal seedlings.
- Polyclonal seedlings are very heterogeneous (30 % of the trees produce 70 % of the total production) leading to more labour and caution for tapping.
- growth of polyclonal seedlings is supposed to be more vigourous that that of clones, however this may be not true with fast growing early starter clones such as those selected for RAS (PB 260 and RRIC 100)

General hypothese on RAS 2.2
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generaly a slow growth pattern (in partticular for durian , local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber imature period will create

a favourable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2 :
- rubber planting material suitability between BLIG and clones for East Pasaman conditions..

LOCATION : WEST SUMATRA , East pasaman, village of Bankok

YEAR :
planting of rubber :
CLONE and BLIG:
-January 1996
- replanting : october 1996
Seedlings from SUMSEL :
- October 1996
These seedlings have been sold by a South-Sumatra project as BLIG planting material but does not seem to be the same type as BLIG.

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees on all plots.

Treatments
PLOT A. Control:
Clonal Rubber PB 260 (1 rep in one farm, pak Udin) and RRIC 100 (1 rep in one farm : Pak Budiman)

PLOT B. BLIG from North-Sumatra

PLOT C. Seedlings from South-Sumatra

EXPERIMENTAL DESIGN
Randomized block system
1 replications per farm
2 farms : so 2 rep

RUBBER

FERTILIZATION

TCSDP fertilization programme only for the first 2 years. No fertilization later.
TCSDP fertilization programme is the following:

IN GRAMMES/tree

	PLANTING TIME October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
UREA		50	50	50	50
SP36		40	40	40	40
KCL			40	40	40

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :

6 weedings ayear , every 2 months, on a regular basis. Loca observation and presence of alang² may change that pattern.

INTERCROPPING

RAINY SEASON
Rice is no a treament is this trial. The same variety at the same amount for fertilization is cropped in all the field.
Local rice has been planted in 1995/96 without fertilization.
Local rice has been planted in 1996/97 without fertilization.
FOR 1997 :
Rice will be planted in september 1997 : local rice + recommended Sembawa fertilisation (100 kg urea + 130 kg SP 36 + 75 kg KCL). Urea is provided in 3 periods : planting time, + 40 days and + 80 days after planting.
Chemical treatment againts pests and diseases.
Weeding : 2 weedings during growth.

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

DOSE IN KG/HA	*UREA*	*SP 36*	*KCL*
BPS	*100*	*160*	*75*

Urea is supplied in 3 times : 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

DRY SEASON

According to farmers strategy: nothing or palawijas : such as groundnut wgich is the best inter crop for dry season.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees acccording to local situation. The associated trees frame should be the same for all trials, or similar.
Weeding : same as for rubber (6 weedings/year).

FIELD SIZE per farm

PLOT SIZE : see field maps
NUMBER OF PLOTS PER REPLICATION : 3 plots for BLIG, seedlings and clone.
NUMBER OF REPLICATION/farm : 2

DATA TO BE COLLECTED

Standart data for all RAS 2.2 :

RUBBER

- rubber growth measurements : diameter, height and worls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labour for each plot.
- soil samples per replication on 0-15 and 15-30 cm.

Total number of soil samples for the 2 farms : 3 plots x 2 rep x 2 soil depths = 12

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of each plot with a sample of 100 grams to be sent to ICRAF/Bogor for water content measurement.

Labour requirement per plot.

Tables and graphs for each trial.

Participatory action research on improved rubber planned for East Pasaman

GAPKINDO/ICRAF SRAP PROJECT

PARTICIPATORY ACTION RESEARCH IN EAST PASAMAN WEST-SUMATRA

RAS	Code	Objective of the trial
2.2	a	Clone PB 260 grown under three contrasting fertiliser treatments
2.2	b	Improved rice varieties with fertiliser treatments
2.2	c	Compare PB 260 with BLIG and clonal seedlings

RAS	Code	Objective of the trial
2.2	a	To identify the most adapted fertiliser programme. Demonstrate the effect of fertiliser application to farmers
2.2	b	To identify and demonstrate the most suitable improved rice varieties , and compare these with the local composite seed mixture under 2 fertiliser treatments
2.2	c	To compare the growth and production of the 3 planting materials.

RAS	Code	Area/plot (m2)	Treatments
2.2	a	1000	Control, P (1ton RP/ha), NPK
2.2	b	1000	2 varieties, 2 fertiliser treatments
2.2	c	1000	3 treatments, BLIG, clonal seedlings and PB 260
3.2			

RAS	Code	Reps	Trial area (ha	No. farmers	Farmers plot size
2.2	a	4	0.8	2	2 reps, 6 plots,
2.2	b	4	0.8	4	1 rep, 4 plots,
2.2	c	2	0.4	2	1 rep, 3 plots,

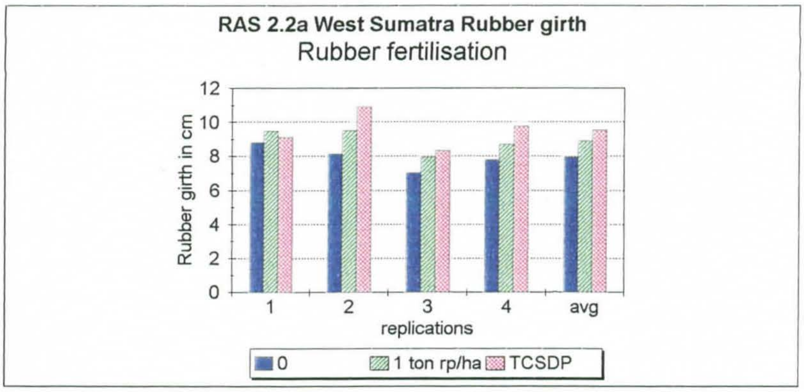
RAS 2 a

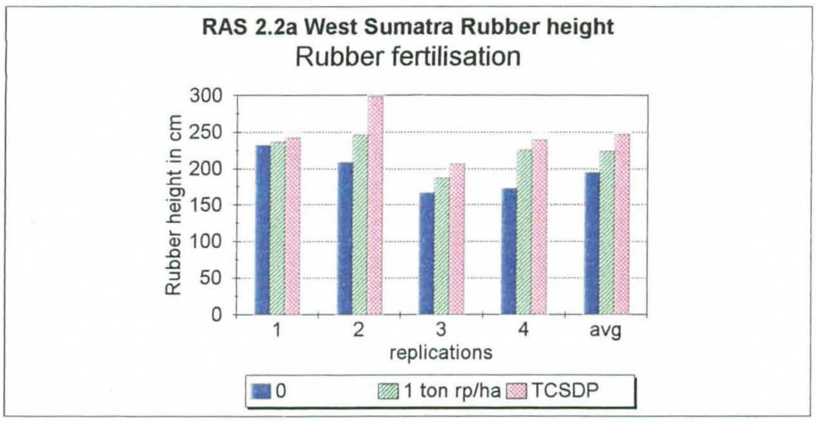
data November 1997

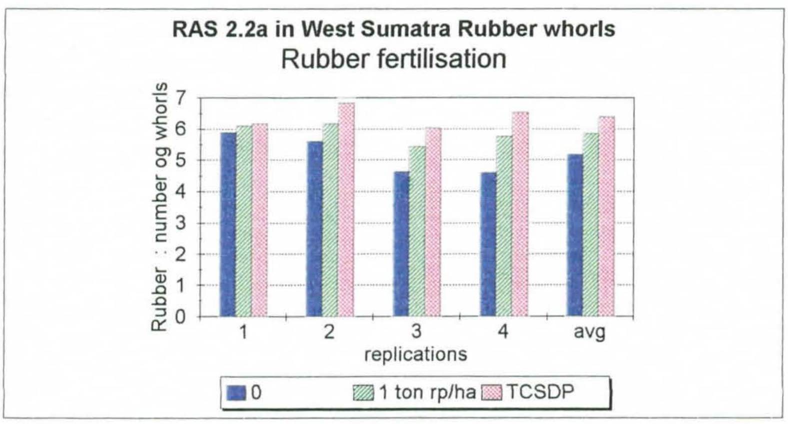
RAS 2.2a / :RUBBER FERTILIZATION IN RAS 2 IN WEST SUMATRA

Nomor		PLOT A			PLOT B			PLOT C	
mean	height A	girth A	whorls A	height B	girth B	whorls B	height C	girth C	whorls C
1	232.3	8.8	5.9	236.7	9.5	6.1	242.5	9.1	6.2
2	208.7	8.1	5.6	246.3	9.5	6.2	298.2	10.9	6.8
3	166.5	7.0	4.6	187.1	8.0	5.4	206.2	8.3	6.0
4	171.7	7.8	4.6	225.5	8.7	5.8	239.2	9.8	6.5
avg	194.8	7.9	5.2	223.9	8.9	5.9	246.5	9.5	6.4

A1 & A1 = Warna, A3 & A1 = Ema



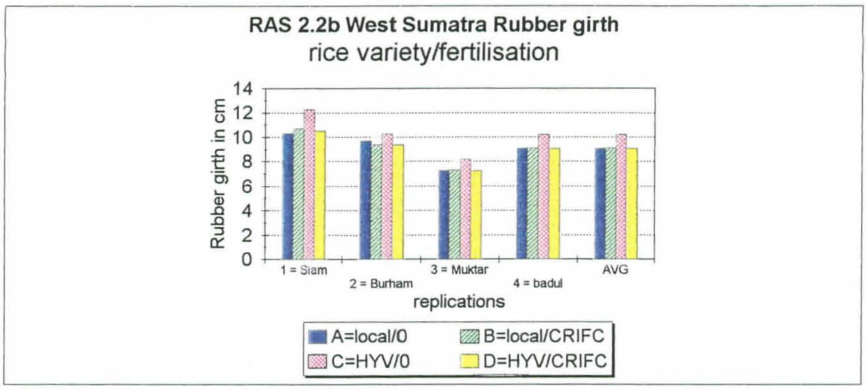


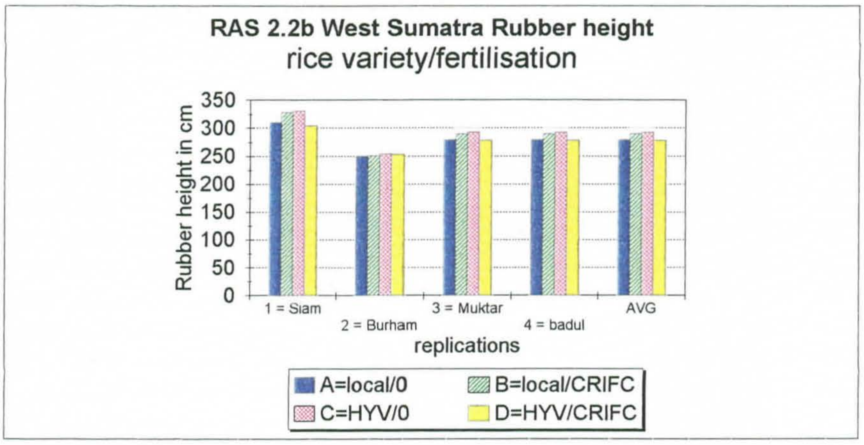


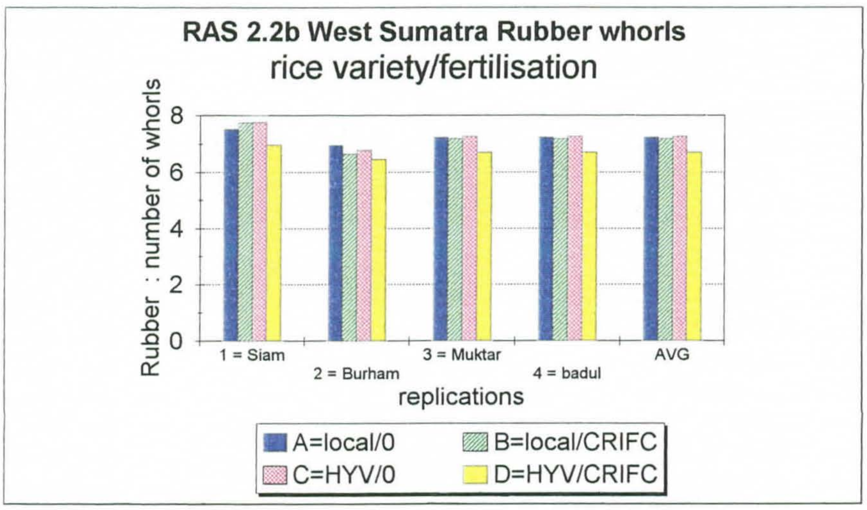
RAS 2 b

RAS 2.2b / RICE INTERCROP FERTILIZATION IN RAS 2 IN WEST SUMATRA

Nomor		PLOT A	A=local/0		PLOT B	B=local/CRIFC		PLOT C	C=HYV/0		PLOT D	D=HYV/CRIFC
Sample	height	girth	whorls	height	girth	whorls	height	girth	whorls	height	girth	whorls
1 = Siam	310.1	10.3	7.5	328.3	10.7	7.7	331.0	12.2	7.8	304.6	10.6	7.0
2 = Burham	249.3	9.7	6.9	250.7	9.4	6.6	254.6	10.3	6.8	253.1	9.4	6.4
3 = Muktar	279.7	7.3	7.2	289.5	7.3	7.2	292.8	8.2	7.3	278.9	7.3	6.7
4 = badul	279.7	9.1	7.2	289.5	9.1	7.2	292.8	10.2	7.3	278.9	9.1	6.7
AVG	279.7	9.1	7.2	289.5	9.1	7.2	292.8	10.2	7.3	278.9	9.1	6.7





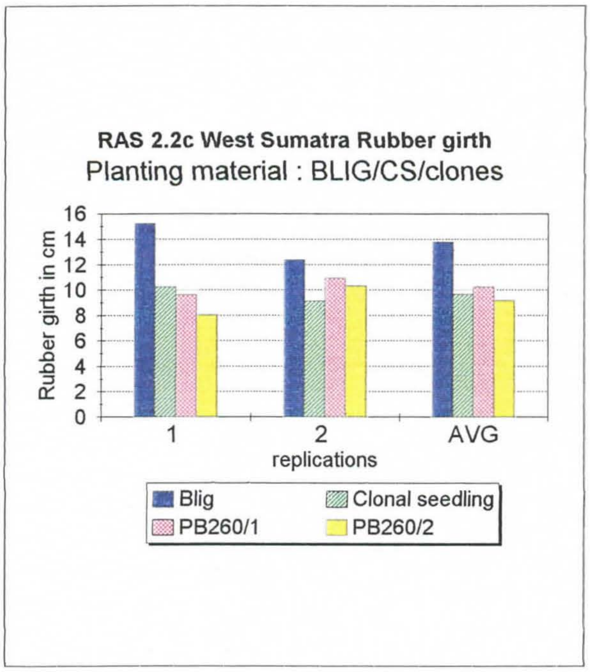


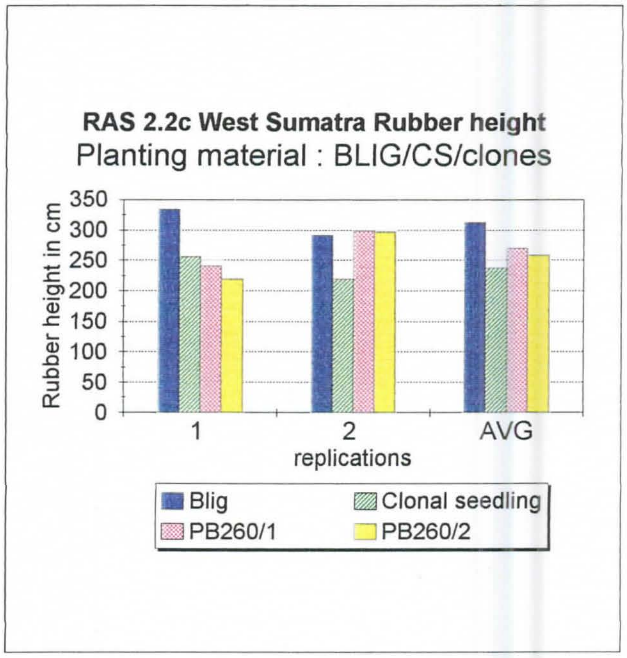
RAS 2 c

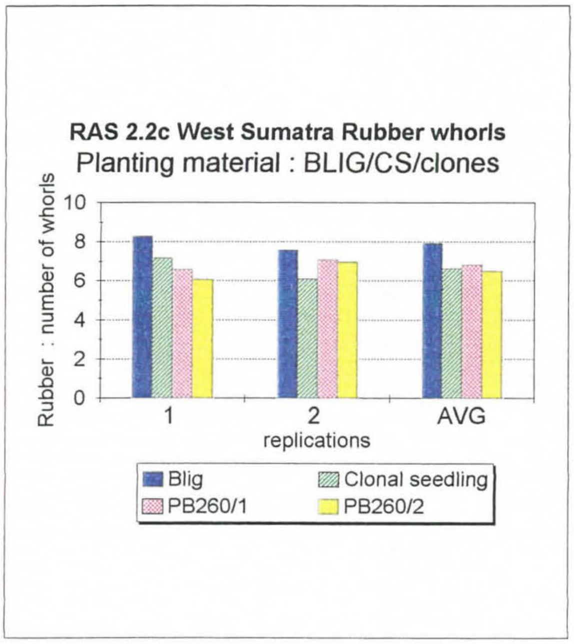
Results from the PKT experimentation
Effect of 1 ton RP/ha on rubber growth

RAS 2.2c / : CLONE VS BLIG and Clonal seedlings COMPARISON IN WEST SUMATRA

rep	treatment		BLIG			clonal seedlings			PB 260			PB 260	
	Sample	height	girth	whorls	height	girth	whorls	height	girth	whorls	height	girth	whorls
1	mean	334.0	15.2	8.3	255.7	10.2	7.2	240.6	9.6	6.6	219.5	8.0	6.1
2	Mean	291.4	12.3	7.6	219.3	9.1	6.1	298.7	10.9	7.1	297.1	10.4	7.0
AVG		312.7	13.8	7.9	237.5	9.7	6.6	269.7	10.3	6.8	258.3	9.2	6.5





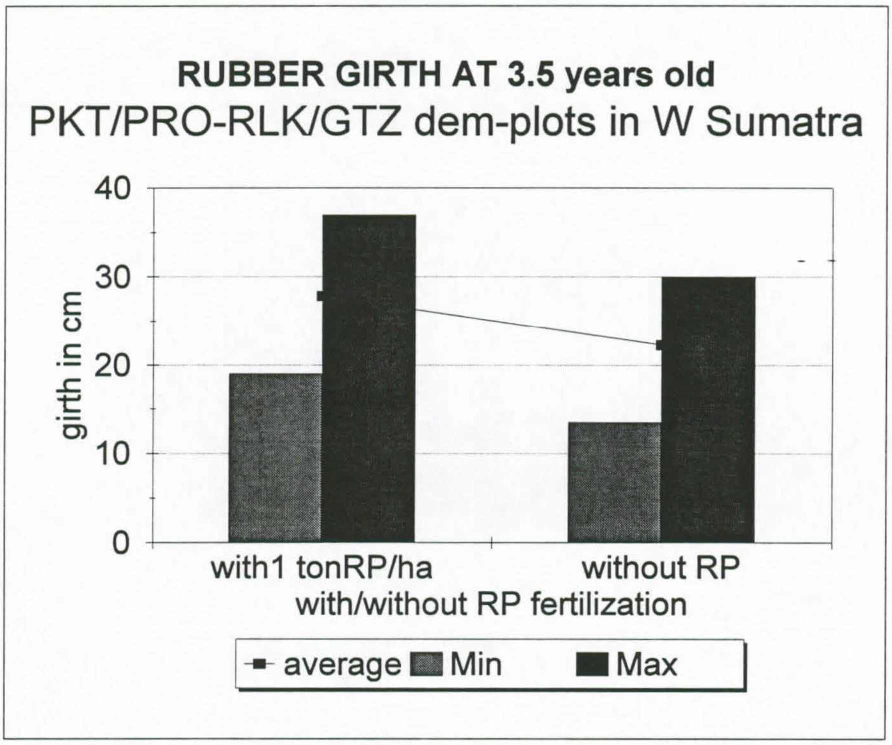


PKT DEMONSTRATION PLOT

BANGKOK VILLAGE EAST PASAMAN AREA

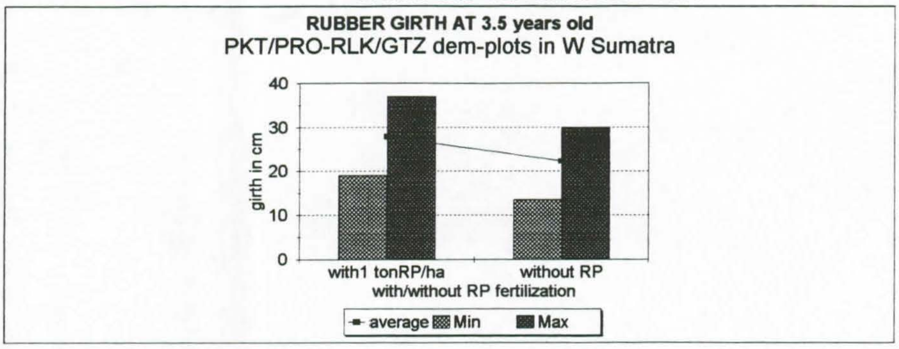
WEST SUMATRA PROVINCE

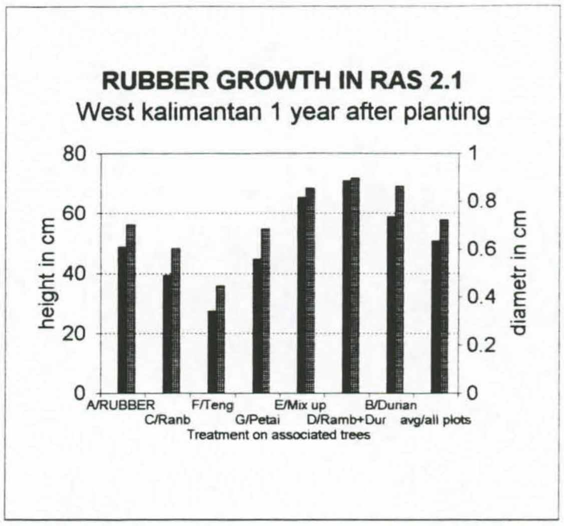
	with 1 ton RP/ha			without RP		
FARMER TREE	BADUL A	SINIH A	MAPI A	DASKI B	SR B	KIMIN B
AVG	**29.60**	**27.13**	**26.65**	**21.42**	**24.05**	**21.22**
STD	3.90	3.93	3.81	2.89	2.89	3.35
STDS	3.97	4.00	3.88	2.94	2.94	3.41
Std error	0.71	0.72	0.70	0.53	0.53	0.61
AVG 3 plots			**27.79**			**22.23**
SD 3 plots			**4.09**			**3.32**
CV			**14.72%**			**14.91%**
Min			19			13.5
Max			37			30



RUBBER GROWTH MONITORING
WEST SUMATRA
PKT demonstration plot

TABLE 8 Planting of rubber : 1993
Growth data collection: June 1996





Summary of the Cost-benefit analysis of RAS systems

Cost-Benefit analysis of RAS technologies compared to jungle rubber and TCSDP rubber monoculture system.

A preliminary economic analysis of 7 rubber based systems ranging from the least intensified, but the most used and traditional in Indonesia - jungle rubber - to the most intensified, RAS 2.2 with annual and perennial intercropping has been done (Penot 1996) through the calculation of NPV (Net Present Value), incremental benefit (compared to the jungle rubber system) and return to labour over the complete lifetime (up to 35 years), the productivity per type of crop, the return to labour and the incremental net benefit for various rubber based cropping patterns compared to jungle rubber in order to compare economic rationale of RAS to other systems (jungle rubber and monoculture).

The 7 systems are described in table 2 and 3.

RAS recommendation domains

In all cases, rubber is the main economic driving force of each system. Income diversification enable farmers to profit from market opportunities for fruits, timber, rattan and other non-timber products. RAS 1 and RAS 2.5 are designed for farmers in remote or pioneer areas with low cash availability and without land shortage. RAS 2.5 is targeted especially for piedmont zones close to the Barisan mountains in Sumatra. RAS 2.2 is the most intensive system aimed at farmers with severe land limitation such as transmigrants. Farmers in degraded areas with Imperata (in West-Kalimantan for instance where the risk is high) are targeted for RAS 3.

The economic rationale of RAS technology.

The incremental benefit of RAS systems is in the same range as that of TCSDP for RAS 1 (see figure 1) and significantly superior for RAS 2.2, 2.5 and 3 due to the non-rubber components production such as fruits, cinnamon or pulp trees production. The most intensive systems, TCSDP and RAS 2.2 are very sensitive to labour cost, in particular for RAS 2.2. Figure 1 shows RAS incremental benefit for 3 labour costs resteiveley : 2000 rp/day for upland rice cultivation labour productivity, 3500 rp/day equivalent to the real local opportunity cost (estate daily wage) and 5 000 rp/day corresponding to the labour productivity of rubber share cropping.
RAS incremental benefit is far higher than that of jungle rubber, even using clonal seedlings, mainly due to the fact that the total income comes from rubber and rubber productivity with clones is multiplied by 3. In addition to other sources of income. Incremental benefit is still very attracting at high labour cost, but then systems are in the same range. RAS systems are aimed to decrease labour requirement and gives a very interesting output in the case of low opportunity cost, which is generally the case in most rubber producing areas except South and North-Sumatra provinces.

Figure 1

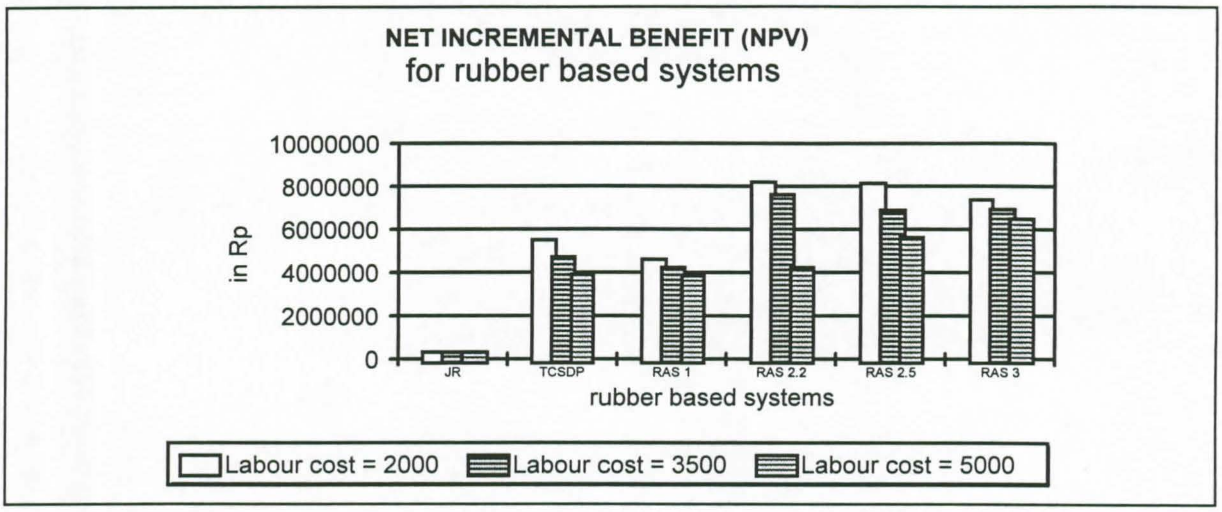
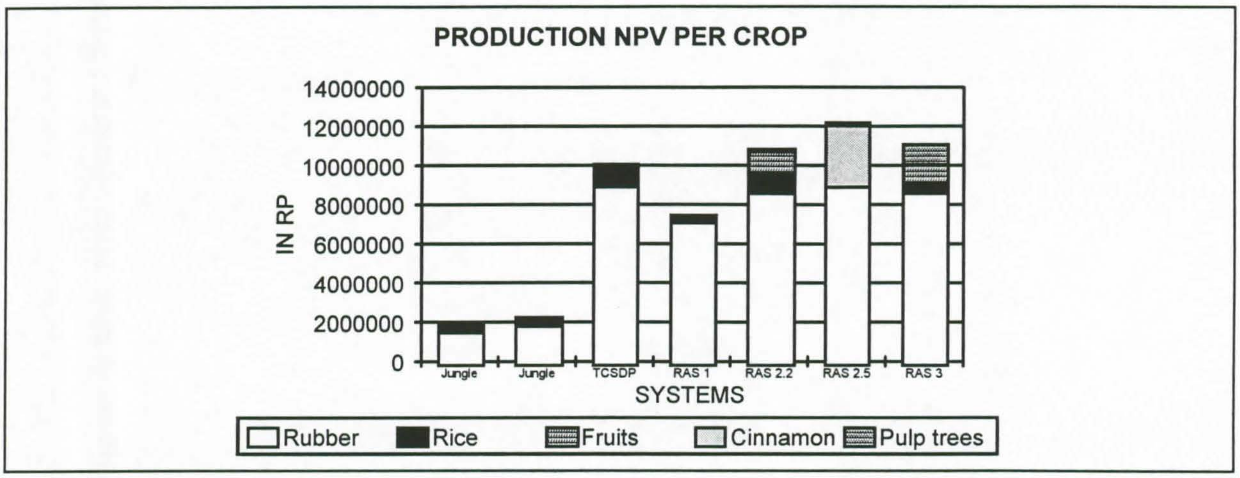


Figure 2 shows that rubber contributes to around 80 % of total income and to 95 % in RAS 1, but the use of Net Present Value of production increase the importance of rice during the immature period and decrease the final value of the wood at the end of lifetime. In fact, clonal rubber wood and timber output is expected to be high enough to able the farmer to further invest in whatever improved cropping system (monospecific plantation of rubber or oil palm or agroforestry systems). Jungle rubber produces not only rubber but also fruits, timber for local use, medicinal plants, rattan and firewood which are generally for self-consumption. Production for self-consumption is not taken into account in this calculation, but is considered as a general benefit for the farmer that is comparable for all systems except TCSDP[1] which is monoculture.

[1] TCSDP like monoclonal rubber plot is the only system without non-rubber products but it is also not an agroforestry system.

Figure 2

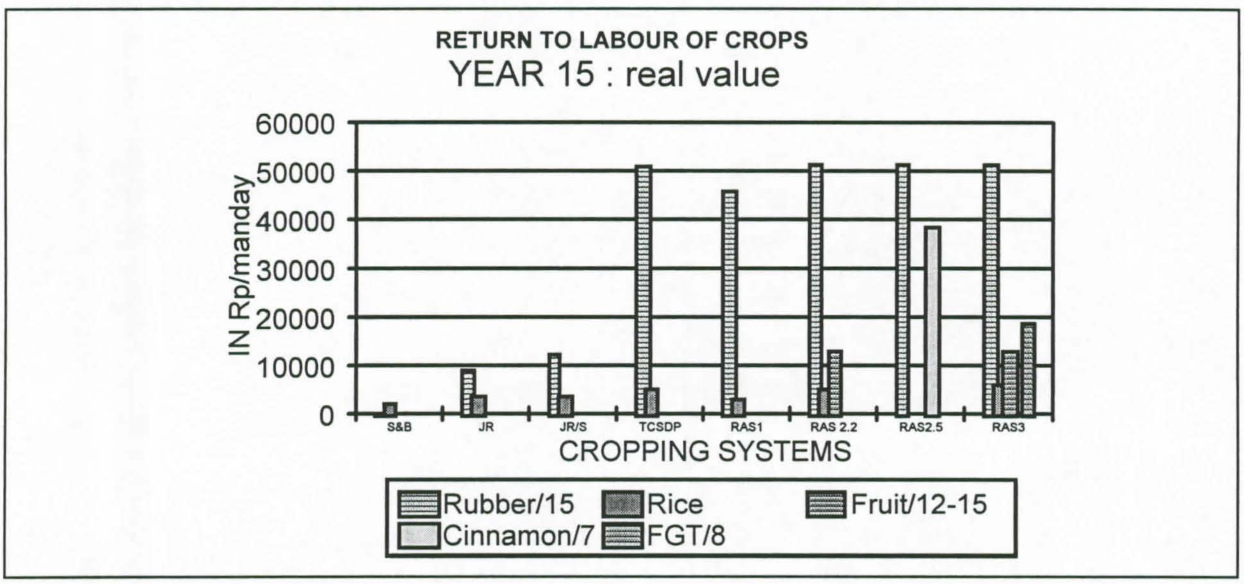


The return to labour : a sensitive argument for farmers in selecting a cropping system.

The evolution from an input extensive system such as jungle rubber into an intensive system such as RAS 2.2 or TCSDP is generally limited by cash availability and labour. Two conditions must prevail for adoption of new technology : limited risks and high return to labour, or at least conservation of return to labour comparable than that of a jungle rubber.

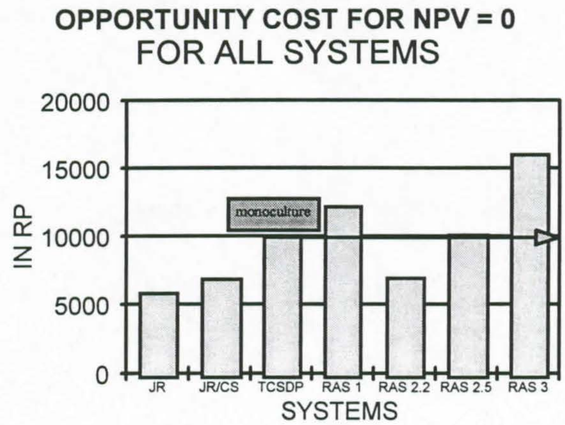
Figure 3 shows rubber return to labour is definitely improved with TCSDP and RAS (around 50 000 RP rock phosphate/man day compared to 9 000 RP rock phosphate for jungle rubber at the year 15 in full potential production).

Figure 3



A better estimation of the return to labour in the long term may be done using the labour cost that leads to Net Present Value equal to zero (fig 4).

Figure 4



The interest of these intermediate systems is that they are still affordable for farmers (investment cost is limited) with limited labour requirement and a good optimization of labour. RAS 1 is typical of that situation. A possible constraint is the distribution of required labour, in particular during the immature period. TCSDP and RAS require labour prior to production systems (respectively 300 to 500 man days for RAS and 600 for TCSDP) in contrasting with jungle rubber (54 man days). In RAS, labour required during immature period is less than TCSDP. The main constraint for adoption of a clonal rubber based system is the necessary minimum level of maintenance during the immature period.

The first 2 to 3 years are critical as rubber clones require a minimum level of weeding (3 to 6 weeding/year compared to 12/year for monoculture). Labour requirement in RAS systems is 50 to 75 % that of TCSDP monoculture system leading to a better adoption of clones by farmers as far as labour during immature period is concerned (figure 6).
After opening, the low tapping frequency of clones leads to a significantly improved return to labour. For these reasons, the use of clonal seedlings do not yield a real significant impact on return to labour as well as income. Exploitation system and tapping frequency are key issues in improving return to labour during production period.
Return to labour is optimized in the RAS 1 system. RAS 1 is aimed to decrease the labour requirements by 30 % during immature period (figure 1). For RAS 2.2, rice intercropping has significant benefits for rubber growth however rice production does not have a great economic value compared to that of rubber. Nevertheless, it is important for some farmers to grow rice during the immature period in order to valorize labour investment, in particular for those with limited access to land such as transmigrants.
This extensive system fits also local farmers' strategies focused on low labour investment. For RAS 3, pulp trees are an important source of additional income. This may help the farmer to reimburse credit.

The initial investment is also an important component of farmers strategies. RAS systems are low to medium inputs systems. Figure 5 shows the importance of initial investment in NPV related to that of TCSDP with respectively 30 %, 55 % and 78 % for RAS 1 and 2.5, RAS 3 and RAS 2.2 of that of TCSDP (if adopted by farmers on their own without projects cost). If we had the TCSDP project cost, estimated at 1.5 millions RP rock phosphate/ha, then it is clear that RAS technology is more affordable for farmers and constitute a very interesting alternative to the current rubber development policy. That is confirmed by the results of the farming systems characterization .

Figure 5

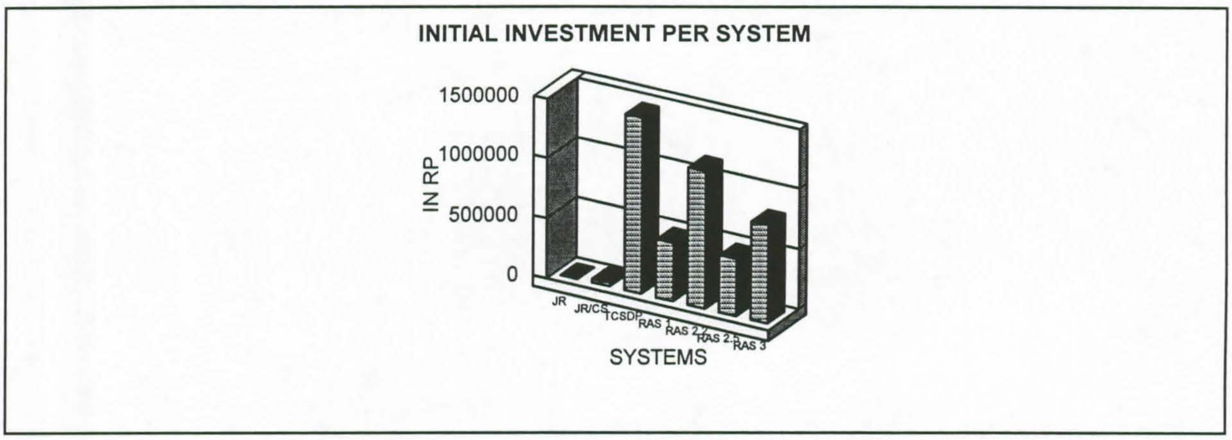


Figure 6

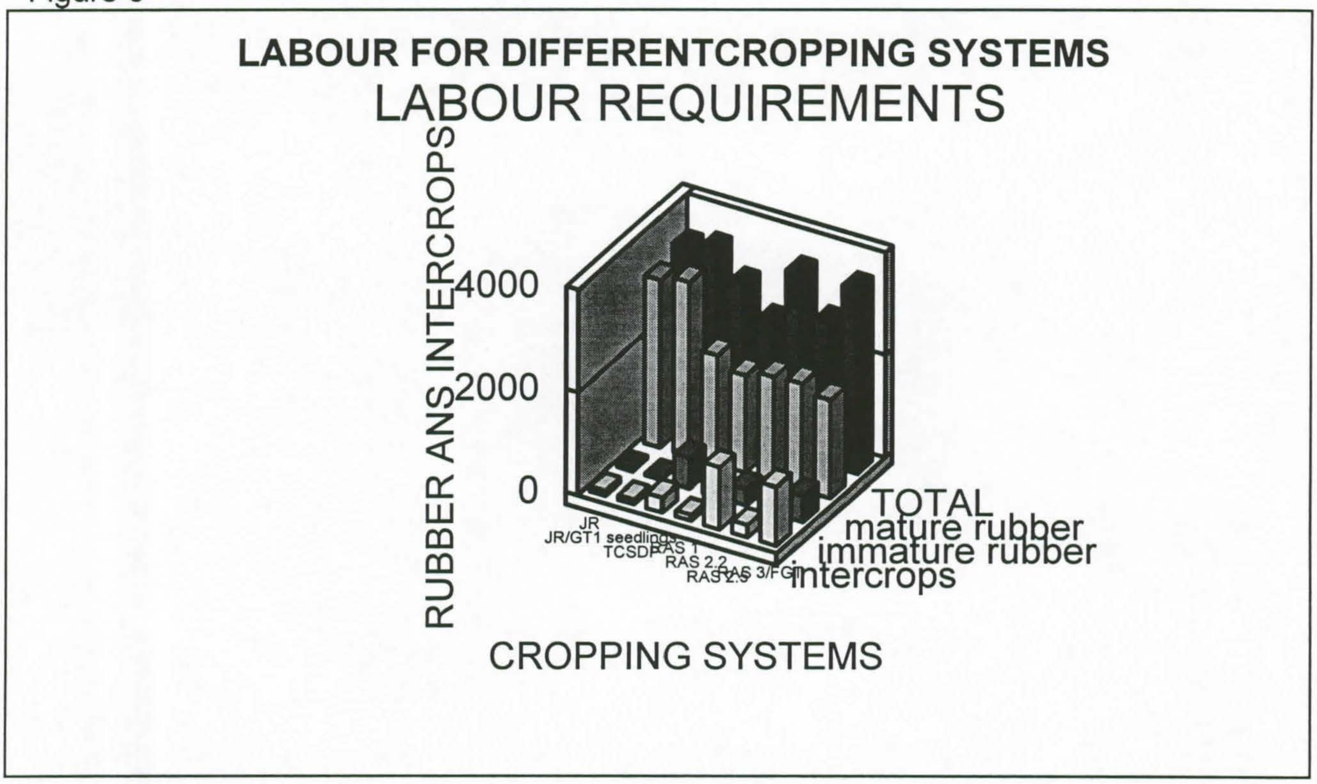


TABLE 2

The 7 systems are the following :

- 1 - **traditional jungle rubber with unselected rubber seedlings** (actual existing system): this system has no cost other than labour in term of inputs and is very extensive.

- 2 - **Jungle rubber with clonal seedlings (GT1)** (existing system, in particular in areas close to estates, but not yet well developed) : this system uses a planting material available in all zones where estates have been established with clones. The cost of establishment is limited to the cost of the seeds or seedlings.

- 3 - **TCSDP like monoclonal rubber plot** (existing as development schemes): this system is based on the traditional project technological package developed by TCSDP[2] including clones and a high investment of weeding and maintenance,. This system requires a high level of input and labour and is ,so far, considered the 'modern and intensified' rubber cropping pattern. Costs are TCSDP estimates (TCSDP reports, DGE)), adapted with 1996 prices. In 1995, TCSDP has introduced upland rice intercropping in its technological package, so we did (for the first 3 years with improved rice and fertilization).

- 4 - **RAS 1**[3] (experimental): this is basically a jungle rubber system using clones and a minimum of inputs (TCSDP like fertilization for the first 2 years) and labour (weeding is limited on the row). The inter-row is not weeded and secondary forest is allowed to grow replacing the traditional LCC covercrops used in TCSDP system. This system is similar to the "jungle weeding" as referred by Djikman (1951) but adapted to modern clones. This is a low input/medium labour system. The challenge here in terms of research is to see if clones can compete and grow well in an agroforestry environment at a given level of inputs (basic fertilization) and labour (minimum number of weeding per year). Emphasis is put on return to labour optimization. Biodiversity is expected to be similar to that of jungle rubber. The target is the farmers in pioneer or remote areas, as well as those with limited labour resources. Biodiversity in RAS 1 is high, similar to that of jungle rubber.

- 5 - **RAS 2.2** (experimental) : rubber + associated trees + rice intercropping the first 3 years. Associated fruits and timber trees are planted at a density of 92 trees/ha. Improved or 4 months local rice (with fertilization) is grown during the immature period. The system is intensive with a medium level of input/labour requirement. Income is diversified with rubber, rice, fruit and timber production.

- 6 - **RAS 2.5** (experimental) : rubber + cinnamon : this system is specifically developed for the Jambi province where cinnamon is a recent opportunity for local farmers. A cinnamon planting density of 3 x 3 meters results in 1100 cinnamon trees/ha intercropped with rubber.

- 7 - **RAS 3.3** (experimental) : rubber + associated trees + FGT (fast growing pulp trees) : this system is designed for degraded lands where Imperata is a major risk. The first year is cropped with rice; immediately after the harvest non climbing covercrops such as Flemingia or Crotalaria are planted in order to limit the level of weeding. Associated trees and FGT are planted in the inter-row. FGT are harvested in the 5th year. This system is specifically developed for West-Kalimantan (Sanggau area) where pulpwood species can be sold to the planned pulp factory.

The main difference between RAS 1 and RAS 2/3 is that RAS 1 requires a specific environment to be set up with surrounding vegetation being forest, jungle rubber or tembawang with no Imperata. The associated trees are those which naturally growing and subsequently selected by the farmer. In RAS 2/3, associated trees are directly planted by the farmers who can choose the species among those which are adapted and are not too competitive with rubber. In RAS 2/3, tree diversity is limited to the cropped species, however farmers may select among the naturally growing species those which have an economic output.
All systems except RAS 2.5 have rice intercropping the first year.

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[2] TCSDP = Tree Crop Smallholder Development Project/World Bank

[3] All Rubber Agroforestry Systems have the following characteristics :
- rubber is planted at 550 trees/ha (6 x 3 meters). The selected clones are PB 260, RRIC 100, RRIM 600 and BPM 1.
- associated trees (if any) are fruits (local and improved rambutan) and local timber trees at 92 trees/ha (9 x 12 meters).
- FGT (Fast Growing pulp Trees) are planted at 3 x 3 in between rubber and associated trees (400 trees/ha). They are harvested the 5th year after planting.
- cinnamon is planted at 3 x 3 in the inter-row and harvested the 7th year.
- fertilization follows TCSDP recommendations for the first 2 years.

TABLE 3

Economic analysis of rubber based cropping systems : characteristics of calculation.

In this first financial analysis, there is no depreciation of initial investment during the immature period. It is assumed that farmers do not use credit in order to simplify the assessment of rubber systems performances. To provide a criteria of comparison for this initial investment, we present the number of days of work at local opportunity cost (generally in a estate nearby for a daily wage of 3 500 rp[4], that is the case in West-Kalimantan) that are required to cover costs of investment. A further analysis should include a credit scheme. A credit scheme will not significantly change the long term financial analysis. Costs and benefits are calculated in net present value (NPV) with value at the end of the period (1 year) with a rate of interest at 15 %, equivalent to the current real interest rate in Indonesia (table 1). The total net benefit includes that of rubber, rice, fruits, cinnamon and timber for the overall lifetime of each system, voluntary limited to 35 years (possibly more). RAS 2.2 and 3 systems with associated trees may also evolve, beyond the rubber lifespan, into fruit and timber based agroforestry systems. Rubber wood from seedlings is counted only as fuelwood with a limited value but may be sold later as a valuable product (for particle board or pulp for instance). Clonal rubber wood is expected to be sold as a valuable timber product in particular for furniture industry. In all case, rubber wood harvest is contracted.

Costs are effective costs observed in current on-farm experimentation of SRAP. Prices are those observed in February 1996. Production and labour requirements are assumptions based on previous surveys (Gouyon, Barlow....) or farmers interviews.

The analysis is based on the situation in West-Kalimantan with no fencing cost (except for RAS 2.5 system, based on rubber and cinnamon in Jambi only). In RAS 2.2 and 3, timber trees are harvested 35 years after planting yielding a modest benefit. Fruit production is annual for petai and jengkol and durian, duku and rambutan are assumed to fruit every 3 years. We also assume that yields are low and only 50 % of the production is actually sold for which gives us 40 producing trees/ha. Distribution between trees is the following : fruit trees : 75 % (70 trees/ha with 60 producing trees) and timber trees : 25 % (22 trees/ha).

Labour for tapping is limited in RAS systems to 120 tapping days (1 tapping day is 0,5 manday) as PB 260 and other selected clones allow a D/3 tapping system (tapping every 3 days) without any decrease in production. Jungle rubber is tapped more frequently (200 tapping/year so 130 man days including other activities). Labour is converted into total man days in our calculation. It is assumed that rubber is tapped by the owner.

Production patterns have been carefully adjusted to account for the normal evolution of production including losses of trees. In RAS 1, 2.2 and 3 ; rubber yield has been slightly reduced (10 %) due to possible competition with associated trees compared to that of a TCSDP monoclonal rubber plot (this is an assumption). RAS 2.5 rubber production is assumed to be similar to that of TCSDP as cinnamon is harvested the 8th year with no further competition. Production and prices for fruit and cinnamon have been assessed from interviews with farmers and ENSO/West-Kalimantan for pulp trees production. TCSDP system may be adopted by farmers on their own or though projects. A line in table 2 shows the actual cost of TCSDP system in project, including project costs (evaluated at 1,5 millions rp in 5 years).

[4]However official minimum daily wage is 4600 rp in March 1996 in Indonesia, the daily wage observed in West-Kalimantan and Jambi provinces is generally close to 3500 rp.

RAS economic analysis shows that the cost of clonal planting material is important (up to 50 % of total costs for RAS 1 fro instance). The production of clonal stumps by farmers themselves seemed to be a possible solution in reducing that initial cost as well as developing a cooperation between farmers through the implementation of nursery activity. That statement leads to the development of a village/community budwood garden and nursery programme in villages where RAS have been implemented, according to farmers deman..

Bibliography

Penot, E. (1996). Improving productivity in rubber based agroforestry systems (RAS) in Indonesia : a financial analysis of RAS systems. GAPKINDO seminar, Sipirok.

List of publications of SRAP.

Table 7

COMPARISON BETWEEN RUBBER BASED AGROFORESTRY SYSTEMS

LABOUR REQUIREMENT AND RETURN TO LABOUR

LABOUR		Upland rice slash and burn system	Jungle rubber unselected seedlings	Jungle rubber clonal seedlings	TCSDP like clonal plantation	RAS 1	RAS 2.2 rice inter-crop	RAS 2.5 Cinnamon inter-cropping	RAS 3 with FGT (*)
% of TCSDP total labour requirement			**113%**	**117%**	**100%**	**81%**	**118%**	**92%**	**119%**
tapping system			D/1, D/2	D/1, D/2	D/3	D/3	D/3	D/3	D/3
FOR RUBBER ONLY/immature period									
% of TCSDP total labour requirement			**9%**	**9%**	**100%**	**73%**	**53%**	**74%**	**86%**
RETURN TO LABOUR (full production)									
RUBBER return to labour : YEAR 15	Rubber/15		**8,979**	**12,210**	**50,839**	**45,714**	**51,246**	**51,246**	**51,246**
Average RICE return to labour (1 or 3 years)	Rice	**1,992**	**3,500**	**3,500**	**5,000**	**2,917**	**5,000**		**6,000**
FRUIT return to labour : YEAR 15	Fruit/12-15						**12,861**		**12,861**
CINNAMON return to labour (year 7)	Cinnamon/7							**38,400**	
FGT return to labour (year 8)	FGT/8								**18,667**
RETURN TO LABOUR ASSESSMENT IN THE LONG TERM									
Labour productivity if NPV = 0			**5,790**	**6,828**	**9,893**	**12,157**	**6,900**	**10,057**	**16,000**

Fig 15 : estimation of the return to labour in the long term

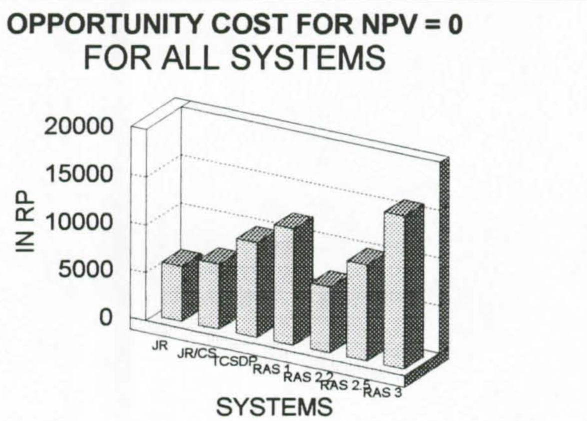
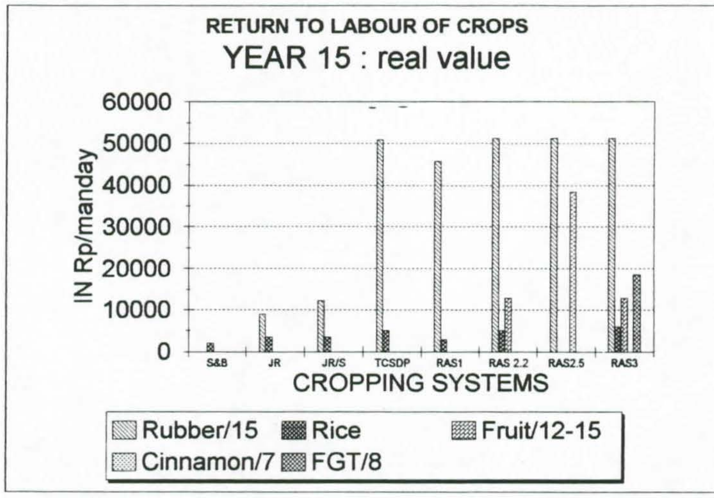


Fig 16 : return to labour at a fixed date



COST BENEFIT ANALYSIS OF DIFFERENT RUBBER BASED SYSTEMS

table 11 : labour requirement per system

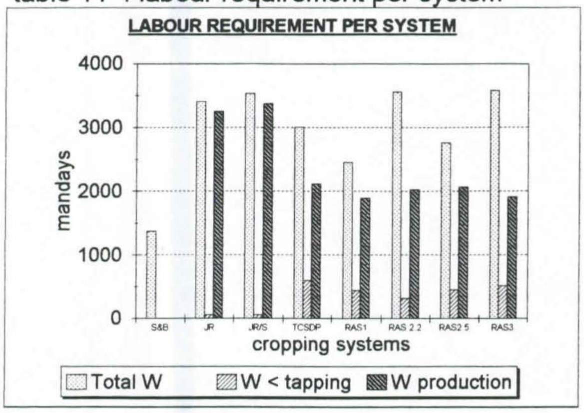


Table 12 : production values per system

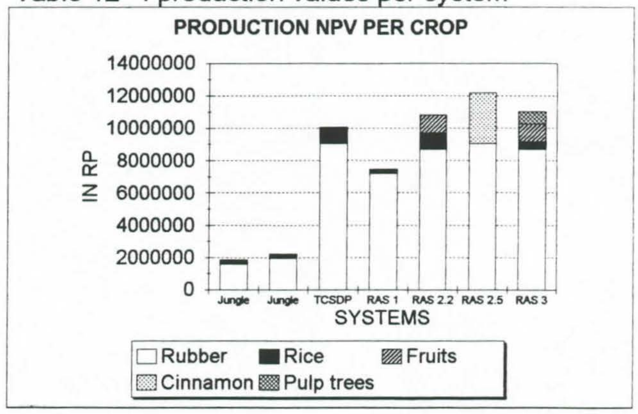


Table 13 : initial investment required per system

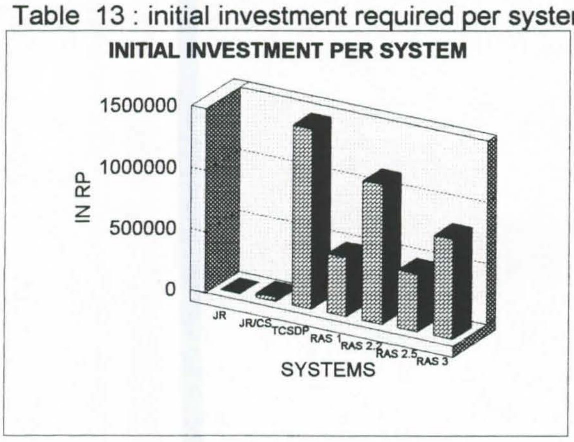
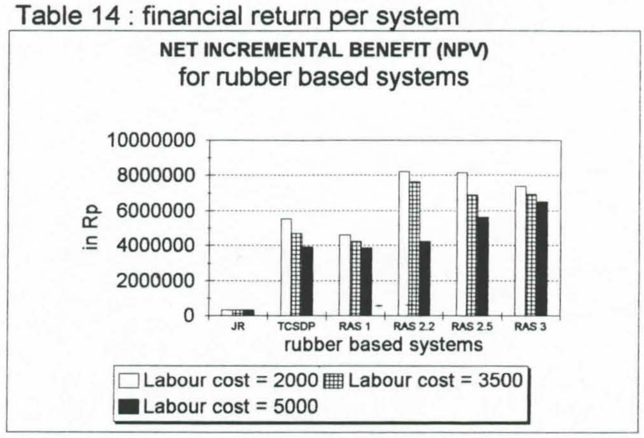


Table 14 : financial return per system



ECONOMIC ANALYSIS ON RAS SYSTEMS (calculated forecast)